

AMMONOIDS OF THE LATE SCYTHIAN (LOWER TRIASSIC)

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ABSTRACT

An evaluation of all taxa of ammonoids of the Late Scythian *Prohungarites* Zone shows the fauna to consist of 65 genera with 154 species. Of the total number of genera, 42 are confined to this zone, 20 genera are known to range up from the preceding *Columbites* and *Owenites* Zones, one genus is known from both older and younger horizons, and two genera are also present in the overlying Anisian. There are 24 genera endemic to the Tethyan region. The western Pacific, eastern Pacific, and Arctic faunas have only two endemic genera each. Indexes of faunal similarity between the major faunas of the *Prohungarites* Zone are presented. The largest number of genera of this zone is found in the Tethyan region. The Arctic region has only approximately 30 percent as many and the western and eastern areas an intermediate number. It is suggested that this is a true faunal

gradient and could well reflect a climatic pattern.

The *Columbites* fauna lying immediately below that of the *Prohungarites* Zone is well known from southeast Idaho and Siberia, and appears to be present in Arctic Canada. This fauna is, as yet, not known in the Tethyan region. The *Columbites* fauna is closely related to that of the *Prohungarites* Zone.

INTRODUCTION

We are well along in the second century of the systematic study of invertebrate paleontology and stratigraphy. During the early phases of this period, published contributions consisted mainly of monographs describing the whole range of fossil forms, then known, for wide geographic regions. This initial pattern of publication was followed by a phase consisting mainly of monographs of faunas of specific stratigraphic units. This second phase gradually merged into a third where specific biological groups, with or without time restrictions, became the focal point of study. We are now in a fourth phase in the history of invertebrate paleontology where it is possible to attempt a total synthesis of animal groups on a world scale for relatively short units of time. The development of this latest phase in paleontology comes at a most appropriate time. Whereas there are still many areas that have received little or no intensive geological study, we do have a considerable fund of data from all parts of the world. In recent years there has developed a more intense interest in the problems of animal evolution and zoogeography. However, towards these goals invertebrate paleontology can make significant contributions only if a sound taxonomic base is present.

We are now in the midst of a great resurgence of interest in the question of permanence or non-permanence of the continents and oceanic basins, brought on primarily by the application of paleomagnetic studies. Paleontology must and can play

an important role in this fundamental re-evaluation of the earth's evolution. The importance of paleontological data to these problems is commensurate with the quality and quantity of data available. The vast majority of the paleontological data accumulated over the past century consists of faunal studies in which genera and species are treated as segregated elements with little or no relevance to other contemporaneous faunas. Syntheses which attempt to evaluate and re-appraise all generic and specific taxa on a global scale are not many. It is such syntheses, however, that will contribute most to the story of the earth's biological and physical history.

In an attempt to achieve a limited goal, I have set up a program to develop a three-dimensional picture of a stratigraphic stage based primarily on ammonites. For this purpose I have selected the Scythian Stage (Lower Triassic). The first requirement of this program is the establishment of a uniform taxonomic procedure based on consideration of all available data. This contribution is devoted to consideration of the two upper zones of the Scythian. In the chapter on systematic paleontology all taxa of Upper Scythian ammonoids are considered. These data provide the basis for the summary chapters concerning population structures, geographic distribution of species and genera, and other problems.

PLAN OF STUDY

The first described species of Lower Triassic (Scythian) ammonites was *Ammonites bogdoanus* von Buch (1831). The first century of study of Scythian ammonoids was focused primarily on documentation of each newly discovered fauna and on attempts to construct a zonal framework. It was recognized very early in the development of our geologic time scale that central and northern Europe were not appropriate areas to establish a chronological framework for the Triassic system based on a succession of marine faunas. The

first attempt to establish a series, stage, and zonal scheme for the marine Triassic was by Mojsisovics, Waagen, and Diener (1895). It was in this paper that the term Scythian¹ was first introduced for the Lower Triassic, and the sequence of the Ceratite beds in the Salt Range of West Pakistan was selected as the type. At this time there had already appeared or were in an advanced stage of preparation Mojsisovics' monumental works on the Alpine Triassic (Mojsisovics, 1873–1902, 1882), Waagen's monograph of the Salt Range Ceratite bed fauna (Waagen, 1895), the faunas of the Lower Triassic of the Himalayas (Diener, 1897), the fauna of the Ussuri Bay (Primorye) region, and the Olenek fauna of northern Siberia (Mojsisovics, 1886, 1888). Thus, by the turn of the century, it was fairly well established that marine formations of Lower Triassic age existed in the Tethyan realm, in the circum-Pacific region and in the Arctic region.

Throughout the early period of study of Lower Triassic ammonoids, the primary guiding philosophy in taxonomy was typology. In fact, at that time there was no alternative—each fauna was new, small, and unique; the correlation of faunas was tenuous at best; and, finally, nomenclatural and species concepts were primitive or absent. The typological approach did facilitate description and comparison, and it led, in time, to a more complete documentation. One needs only to examine many original collections upon which the early classic studies were made, to have data on their collecting, and to know the prevailing geological and zoological philosophies, to appreciate why the faunas were treated as they were. Whereas one can understand and appreciate the guiding philosophies behind these early studies, it is quite clear that the resulting conclusions are not satisfactory for many purposes.

¹The Scythians are an ancient nomadic tribe that occupied the area north of the Caspian Sea, the region which yielded *Ammonites bogdoanus*.

TABLE 1. SUMMARY OF NUMBERS OF SPECIES AND SPECIMENS DESCRIBED IN SIXTEEN MAJOR PUBLICATIONS ON LOWER TRIASSIC (SCYTHIAN) AMMONOIDS.

		Percent
Total species described	1194	
Species described on basis of 1 specimen	548	46
Species described on basis of 2 specimens	237	20
Species described on basis of 3 specimens	89	7.5
Species described on basis of 4 specimens	63	5
Species described on basis of 5 specimens	38	3
Species described on basis of 6-10 specimens	104	8.9
Species described on basis of 11-20 specimens	57	5
Species described on basis of >20 specimens	55	4.6

An analysis of the taxonomic treatment in 16 major publications on Lower Triassic (Scythian) ammonites is summarized in Table 1. These publications contain the description or documentation of 1,194 species of which 548 (46 percent) were based on a single specimen. In fact, only 216 species (18.5 percent) were based on 6 or more specimens. When one looks at only the new species described in these 16 monographs one gets a clearer insight into early taxonomic procedures. These data are summarized in Table 2. There are 668 new species of which 308 (46 percent) are based on a single specimen. Only 100 of these new species (15 percent) were based on 6 or more specimens.

Although at any one period there were usually only from one to four active workers on Lower Triassic ammonoids, a vast amount of geologic and paleontologic data was accumulated during a century or so of study. I believe we now are in a position to approach the problem as a whole and not in terms of isolated parts, as has been the pattern in the past. The first step in such a synthesis is a thorough restudy of all available type collections of the early classic studies. I have had the opportunity of studying the following faunas: the Werfen fauna described by Kittl (1903), deposited in the Natural History Museum, Vienna; the Albanian *Subcolumbites* fauna described by Arthaber (1908, 1911), deposited in the Paleontological Institute, University of Vienna; the *Subcolumbites* fauna

of Chios described by Renz and Renz (1948), deposited in the Natural History Museum, Basel; the Lower Triassic faunas of Timor described by Welter (1922), deposited in the Paleontological Institute, Bonn, and at Delft; various collections from the U.S.S.R. described by Mojsisovics (1882, 1886), Popov (1961), and Kiparisova (1961); the Kashmir fauna, described by Diener (1913); the Himalayan fauna described by Diener (1897) and Krafft and Diener (1909), deposited in the Geological Survey of India, Calcutta; the fauna of the Lower Triassic of Spitsbergen deposited in the Paleontological Institute, Stockholm, and the Arctic Institute, Norway; the fauna of Arctic islands of Canada and British Columbia described by Tozer (1961a, 1965a, b) and deposited in the Geological Survey of Canada, Ottawa; the faunas of the western United States described by J. P. Smith (1932), deposited in the U.S. National Museum, Washington; and finally the large collections in the British Museum (Natural History). In addition I have had before me new collections made by myself in Nevada, Utah, Idaho, Madagascar, Afghanistan, and the Salt Range of West Pakistan. The only large fauna of Lower Triassic ammonites that I have not personally examined is that from south China, described by Chao (1950, 1959).

The examination of these many faunas allowed a direct comparison of related taxa. Many specimens, several of them types, had been inadequately, and in some cases

TABLE 2. SUMMARY DATA ON NUMBERS OF SPECIMENS ON WHICH NEW SPECIES WERE ESTABLISHED IN THE SAME SIXTEEN MAJOR PUBLICATIONS ON LOWER TRIASSIC (SCYTHIAN) AMMONOIDS AS TABULATED IN TABLE 1.

		Percent
Total new species	668	
Species established on basis of 1 specimen	308	46
Species established on basis of 2 specimens	137	20
Species established on basis of 3 specimens	55	8
Species established on basis of 4 specimens	42	6
Species established on basis of 5 specimens	25	4
Species established on basis of 6–10 specimens	48	7
Species established on basis of 11–20 specimens	28	4
Species established on basis of >20 specimens	24	4

misleadingly described or illustrated. The numbers of specimens in these collections vary greatly. In some, e.g. the Salt Range and Himalayan collections, only the figured specimens of the original monographs are available, whereas the *Subcolumbites* fauna of Chios, described by Renz and Renz (1948) and preserved in the Natural History Museum, Basel, is nearly twice as large as indicated in the original monograph.

In approaching the problem of evaluation and synthesis of all these faunas, I elected to study them zone by zone. In this paper I am treating the two upper zones of the Scythian, the *Prohungarites* Zone and the *Columbites* Zone. Rather than focus my studies on a fauna by fauna analysis, I chose to make the genus my unit of study. For each genus of late Scythian ammonoids, an analysis was made of all species and specimens that had been or should be assigned to it. For many of the genera there were usually one or more faunas which contained an appreciable number of specimens of a species, thereby yielding data on intraspecific variation. The insight gained from studies of species represented by large numbers of specimens was of great help in the analysis of species represented by one or very few specimens from other localities. In essence, the analysis of a population of many specimens provided the framework within which isolated specimens could be more logically interpreted. Essentially, none of the previous studies

on these late Scythian ammonoids gave more than token tribute to the range of morphological variation in their species. Even though many of the faunas from single horizons and localities had yielded an abundance of certain taxa, emphasis was placed on "differences" rather than similarities. In many of these cases it can be clearly demonstrated that within the fauna, one is dealing with a highly variable single species complex rather than with a complex of several species of a genus. In most such cases species were differentiated on the basis of differing shell parameters, that is, degree of whorl compression, involution, suture, etc. Plots of measurements of large numbers of specimens often show the particular distinguishing parameters to be part of a gradational series.

The total numbers of specimens in nine faunas of the *Prohungarites* Zone and the numbers of specimens on which the species are based are summarized in Table 3. The numbers of species for each of these faunas are based on the results presented in the systematic portion of this paper. The number of species based on 20 or more specimens is relatively small. At the same time, these relatively few species include anywhere from 36 to 90 percent of the total number of specimens in these faunas.

It is thus quite apparent that only about 25 percent of the total number of species for the *Prohungarites* Zone have been established on the basis of samples of reason-

TABLE 3. SUMMARY DATA ON NUMBERS OF SPECIMENS AND THE NUMBERS OF SPECIMENS PER SPECIES IN NINE MAJOR FAUNAS OF THE *PROHUNGARITES* ZONE.

	Albania	Chios	China	Primorye	B. C.	Tobin	Timor	Ellesmere Is.	Hammond Cr.
Total specimens in collection	730	1900	97	97	41	186	24	23	296
No. of species in fauna	32	41	21	17	11	7	11	5	11
No. of species with 50 specimens	5	9	0	0	0	2	0	0	1
Percentage of total specimens	53.4	49.0	0	0	0	53.7	0	0	67.5
No. of species with 20-49 specimens	6	9	0	1	0	2	0	0	2
Percentage of total specimens	27.8	12.5	0	36.2	0	34.7	0	0	23.6
No. of species with 10-19 specimens	7	3	2	0	1	1	0	1	0
Percentage of total specimens	15.0	2.4	26.7	0	36.5	5.4	0	47.8	0
No. of species with 5-9 specimens	1	7	6	6	2	1	1	1	2
Percentage of total specimens	0.7	2.6	43.3	41.2	31.7	3.7	25	26.1	6.0
No. of species with 1-4 specimens	13	13	13	10	8	1	10	3	6
Percentage of total specimens	3	1.5	30	22.6	31.7	2.2	75	26.1	2.7

able size. Note the difference in these figures from those given in Tables 1 and 2. Species based on few specimens are difficult to evaluate. If two or more species are based on few specimens from the same horizon and locality and are differentiated on criteria known to be highly variable in related groups, I have tended to synonymize them. The prime assumption is that a larger sample would "fill in" the morphological gap with gradational forms. However, species based on few specimens from widely separated localities are generally kept separate even though there is a strong indication that they may be identical with other named species.

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LOWER TRIASSIC CHRONOLOGY

The name Scythian was first introduced as a series name for the Lower Triassic by Waagen and Diener in Mojsisovics, Waagen, and Diener (1895); the sequence for the Salt Range of West Pakistan was selected as the type, with the addition of the *Otoceras woodwardi* Zone of the Himalayas at the base of the sequence (Table 4).

TABLE 4. ZONAL SCHEME FOR THE LOWER HALF OF THE TRIASSIC SYSTEM FOR THE TETHYAN REALM SUGGESTED BY MOJSISOVICS, WAAGEN, AND DIENER (1895).

Series	Stage	Substage	Mediterranean Trias Province		Indian Trias Province	
			Zone of Tethyan facies	Formations	Zone of Tethyan facies	Formations
Dinarian	Anisian	Bosnian	Zone of <i>Ceratites trinodosus</i>	U. Muschelkalk	Zone of <i>Ptychites rugifer</i>	Muschelkalk of the Himalayas
		Balatonian	Zone of <i>Ceratites binodosus</i>	L. Muschelkalk	Zone of <i>Sibirites prahlada</i>	Beds with <i>Rhynchonella griesbachi</i> in the Himalayas
	Hydasopian				8. Zone of <i>Stephanites superbus</i>	Upper Ceratite limestone, Salt Range
Scythian	Jakutian				7. Zone of <i>Flemingites flemingianus</i>	Ceratite sandstone, Salt Range Subrobustus beds, Himalayas
			Zone of <i>Tirolites cassianus</i>	Werfen Beds	6. Zone of <i>Flemingites radiatus</i>	
					5. Zone of <i>Ceratites normalis</i>	
	Brahmanian	Gandarian			4. Zone of <i>Proptychites trilobatus</i>	Ceratite marls, Salt Range
				Eastern Alps	3. Zone of <i>Proptychites laurencianus</i>	
					2. Zone of <i>Gyronites frequens</i>	Lower Ceratite limestone, Salt Range
		Gangetian			1. Zone of <i>Otoceras woodwardi</i>	Otoceras beds, Himalayas

TABLE 5. ZONAL SCHEME FOR THE LOWER TRIASSIC (SCYTHIAN) PROPOSED BY SPATH (1930).

	Ages	Zones (India)	Some Equivalents
EO-TRIAS	Upper	Stephanitan	<i>Arctoceras</i> beds, Spitsbergen; <i>Olenekites</i> beds, N. Siberia.
		Columbitan	<i>superbus</i> ? <i>Columbites</i> beds, Albania; <i>Anasibirites</i> beds, Spitsbergen, Utah, Timor; <i>Tirolites</i> beds, Werfen.
		Owenitan	<i>Meekoceras</i> beds, California.
	Lower	<i>flemingianus</i>	<i>Meekoceras</i> beds, Timor;
		<i>volutus</i>	<i>Hedenstroemia</i> beds, Himalayas (lower part).
		Flemingitan	
		Gyronitan	<i>fallax</i> "Ophiceras" beds, Timor. <i>rotundatus</i> "Meekoceras" beds, Himalayas. <i>radiosus</i> <i>Proptychites</i> beds, Primorve. <i>Proptychites</i> beds, Greenland.
		Otoceratan	<i>woodwardi</i> <i>Otoceras</i> beds, Greenland.

The Scythian was thus proposed as a series division which included seven ammonoid zones, but the zonal context of the Scythian has since undergone considerable change. What is so puzzling is that Waagen and Diener separated from the Scythian the fauna of the Upper Ceratite limestone (zone of *Stephanites superbus*) of the Salt Range, establishing a new stage (Hydaspien) of the Middle Triassic. This was done on the basis of what they interpreted as a striking change between the faunas of the Upper Ceratite limestone and the underlying members of the Ceratite beds. The basis of Waagen and Diener's correlation of these divisions was summarized as follows: "Es kann wohl nicht in Zweifel gestellt werden, dass die tieferen Abteilungen der Ceratiten-Schichten als zeitliche Aquivalente jener Bildungen anzusehen seien, welche in Mittel-Europa den Namen 'Buntsandstein' tragen. Andererseits jedoch haben wir gesehen, dass angefangen von den tiefsten Ablagerungen des Lower Ceratite Limestone bis hinauf zur oberen Grenze der Ceratite Sandstones eine kontinuierliche Serie der Cephalopoden-Faunen angetroffen wird, dass aber vom Ceratite Sandstone zum Upper Ceratite Limestone ein beträchtlicher Wechsel sich einstellt. Hier muss also eine Formations-grenze durchgezogen werden, und diese

Grenze kann nur jene zwischen der Skythischen und Dinarischen Serie sein.

Wir glauben daher die Oberen Ceratiten-Kalke an die Basis der Dinarischen Serie stellen zu sollen und betrachten sie innerhalb der letzteren als den Typus einer besonderen Stufe. Die Bezeichnung der letzteren als Hydaspiische Stufe ist dem alten Namen des die Salt Range an ihrer Ostseite umfliessenden Ithelium (Hydaspes) entnommen" (Mojsisovics, Waagen, and Diener, 1895:1291). This scheme of classification was completely accepted by Smith (1896, 1901, 1904).

Noetling (1901, in Frech 1905) interpreted the fossiliferous Triassic beds of the Salt Range (through the zone of *Stephanites superbus* of the Upper Ceratite limestone) as including a complete succession of faunal zones for the Scythian. This view was held by Diener (1912:256), Welter (1922:92), and others.

This view on the age span of the Ceratite beds and the scope of the Scythian stage generally prevailed until Spath (1930:76) published a preliminary scheme for the subdivisions of the Scythian (Table 5). This is an extremely interesting modification of the earlier attempt to establish subdivisions of the Scythian. This scheme differed in detail from the proposals and conclusions of previous authors, but it agreed with

TABLE 6. ZONAL SCHEME FOR THE UPPER HALF OF THE LOWER TRIASSIC (SCYTHIAN) PROPOSED BY SPATH (1934).

Divisions		Zones	Equivalents
Upper Eo-Trias	Prohungaritan (Olenikitan ?)		{ Upper <i>Arctoceras</i> beds, Spitsbergen. Olenek beds, Siberia (<i>partim</i>). <i>P. middlemissi</i> beds, Kashmir. <i>Subcolumbites</i> beds, Albania, Timor.
	Columbitan	{ <i>Columbites</i> <i>Tirolites</i>	{ <i>Columbites</i> beds, Idaho. <i>Tirolites</i> beds, Alps, etc., Idaho.
			{ <i>Anasibirites</i> beds, Timor, Utah. Chocolate Limestone, Byans? Upper Ceratite Limestone, Salt Range.
	Owenitan	{ <i>Anasibirites</i> <i>Owenites</i> <i>Pseudosageceras</i>	{ <i>Kashmirites</i> beds, Kashmir, Timor. <i>Meekoceras</i> beds, Timor, Idaho, California. Timor, Himalayas, W. America.

several of these in having a single zone (*Stephanites superbus*) to represent most of the upper Scythian. At the same time, within the late Scythian, Spath (1930:76) recognized three ages: the Owenitan, Columbitan, and Stephanitan.

Spath's proposal was admittedly a tentative scheme in need of further analysis. What was critically lacking, especially for the upper part of the scale, were sufficient stratigraphic sections with these faunal zones in sequence. Spath was cognizant that Smith (1904), Hyatt and Smith (1905), and Smith (1914) had reported Scythian ammonoid faunas in sequence in southeastern Idaho, but published data were very limited. Smith's (1932) monograph on the Lower Triassic ammonoids of North America provided a comprehensive treatment of these ammonoid faunas. In southeastern Idaho, Smith encountered within the Thaynes Formation a sequence of three ammonoid zones which formed the basis for the upper part of his chronologic scheme for the Lower Triassic:

<i>Columbites</i> Zone	{	<i>Anasibirites</i> Subzone
<i>Tirolites</i> Zone		<i>Owenites</i> Subzone
<i>Meekoceras</i> Zone		<i>Pseudosageceras multilobatum</i> Subzone

As my own monograph is devoted to the ammonoid faunas of the upper Scythian,

no further discussion is needed here in regard to the zones of lower Scythian. A comprehensive discussion of the *Meekoceras* Zone has been published by Kummel and Steele (1962), and Kummel and Erben (1968).

Smith considered his *Anasibirites* Subzone to be equivalent to the fauna of the Upper Ceratite limestone of the Salt Range. Smith furthermore considered the specimen (presumably from the topmost limestone of the Dolomite beds) that Waagen (1895: 130, pl. 21, figs. 1a-c) described as *Pseudharpoceras spiniger* as allied to his own species, *Pseudharpoceras idahoense*, from the *Columbites* fauna of southeast Idaho, and thus of *Columbites* Zone age. This scheme enlarged the scope of the Scythian.

Smith's zonal scheme and analysis of the Scythian came under the searching pen of L. F. Spath (1933, 1934). Though Spath was rather caustic in his remarks on Smith's zonal scheme, the differences between these two authorities were not that extensive. Spath presented a new scheme of zones and correlations in 1934; that for the upper half of the Scythian is shown on Table 6. It can readily be seen that this zonal scheme differs from that proposed by Smith (1932) mainly in the introduction of a division of one or more zones above the Columbitan. In this conclusion Spath was guided mainly by "intuition," which was

supported by the biologic character of the faunas. Stratigraphic data on the faunas he assigned to his Prohunganaritan division were either completely lacking or very ambiguous. In his conclusions, explaining the significance of the Prohunganaritan division, Spath (1934:34) states: "I am merely relying on the obvious differences between the lowest Anisian and the highest Scythian faunas so far known, and the only difficulty is to find a name for this time interval that will prove sufficiently accurate to serve for a label, even if it is not the best that could ultimately be proposed." Spath's conclusions regarding additional zones above the *Columbites* Zone were verified with the discovery of a *Prohunganarites* fauna in the Thaynes Formation of southeast Idaho, 1,000 feet above the *Columbites* fauna (Kummel, 1954).

In recent years a number of additional localities have been studied which have yielded sequences of ammonoid faunas in upper Scythian formations. Aside from southeastern Idaho, good stratigraphic sections with fossil faunas are now known for Ellesmere Island (Tozer, 1961a, 1965a), the Primorye Region around Vladivostok (Kiparisova, 1961; Zakharov, 1966), Kwangsi, China (Chao, 1959), the Salt Range of West Pakistan (Kummel, 1966), and Afghanistan (Kummel, 1968). In southeast Idaho, Utah, Ellesmere Island, Primorye Region, and northern Siberia, the upper Scythian comprises a sequence of three distinctive faunas: the *Owenites* (or *Meekoceras*) fauna, the *Columbites* fauna, and at top the *Prohunganarites* fauna or its equivalents. The *Columbites* fauna is not known from south China, West Pakistan, or Afghanistan. Other areas that have yielded faunas of *Prohunganarites* Zone age but are isolated in having no other Scythian ammonoid faunas above or below are those of the Werfen Formation of southeast Europe, Albania, Chios, Mangyshlak Peninsula, Kashmir, Timor, New Zealand, Japan, and Nevada (Tobin Formation).

Even though there has been a vast in-

crease in the amount of data on Scythian strata and faunas over the past decade, considerable differences of interpretation on the correlation of late Scythian zones persist. Kiparisova and Popov (1956) rejected Spath's (1934) Prohunganaritan division and accepted Columbitan as the latest Scythian biostratigraphic unit. They considered this division as including the *Olenekites* fauna of northern Siberia, the *Subcolumbites* fauna of the Primorye Region, Albania, and Chios, and the *Arctoceras* fauna of Spitsbergen. At a later date these two authors (Kiparisova and Popov, 1961) modified their late Scythian chronology and accepted a *Prohunganarites* Zone as the latest Scythian zone, overlying a *Columbites* Zone. Their *Prohunganarites* Zone was then stated to include the following faunas: *Prohunganarites middlemissii* of Kashmir, the *Prohunganarites* fauna of southeast Idaho, the *Olenekites* fauna of northern Siberia, and *Subcolumbites* fauna of the Primorye Region, Albania and Chios, the *Procarnites-Leiophyllites* fauna of Kwangsi, China, and the *Stacheites* Zone of Astakhova (1962) of the Mangyshlak Peninsula. Later, these authors introduced a further revision (Kiparisova and Popov, 1964) in the correlation of late Scythian faunas. They now considered the *Olenekites* fauna of northern Siberia, as well as the *Subcolumbites* fauna of the Primorye Region, as being of *Columbites* Zone age. The correlations of the *Prohunganarites* Zone included a new but undescribed *Prohunganarites* element from northern Siberia, a questionable *Prohunganarites* from the Primorye Region, the Kashmir *Prohunganarites middlemissii*, the *Prohunganarites* fauna of southeast Idaho, and the *Procarnites-Leiophyllites* faunas of Kwangsi, China.

Our knowledge of the Scythian of China greatly increased with the appearance of a large monograph by Chao (1959) on faunas from Kwangsi. Chao followed the lead of Kiparisova and Popov (1956) in using the Columbitan division to encompass all of the late Scythian. For Kwangsi Province,

Chao recognized three zones within his Columbitan division, namely:

Procarnites-Leiophyllites Zone

Columbites costatus Zone

Tirolites darwini Zone

The paleontology and stratigraphy of these Kwangsi faunas are discussed in detail on page 351. It will suffice here to summarize my conclusions. The *Tirolites darwini* Zone was recognized from a single, fragmentary specimen from an isolated horizon. This specimen is not well enough preserved to be identified. The name-giving species of the second zone, *Columbites costatus*, is a synonym of *Prenkites timorensis*. The fauna listed as comprising the *Procarnites-Leiophyllites* Zone was derived from loose blocks. The assemblage of species and genera which were assigned to the *Columbites costatus* Zone and the *Procarnites-Leiophyllites* Zone are such that one can only conclude they are part of a single zone. Recent contributions by Tozer (1961a, 1965a, b) have shown that British Columbia and the Arctic islands have faunal sequences comparable to those of southeast Idaho.

Late Scythian faunas lying in stratigraphic position above the mid-Scythian *Owenites* Zone are now known from nine localities. In Afghanistan a *Subcolumbites* fauna occurs immediately above an *Owenites* fauna (Kummel, 1968) and the same situation is present in the Salt Range and Surghar Range of West Pakistan (Kummel, 1966) and in Kwangsi Province of south China (Chao, 1959). In the Primorye Region the *Subcolumbites* fauna is stratigraphically above a *Columbites* fauna which in turn lies above an *Owenites* fauna. In northern Siberia the *Olenekites* fauna occurs above a *Columbites* fauna which, in places, lies above an *Owenites* fauna. The same is true for Ellesmere Island. In southeastern Idaho the uppermost Scythian is marked by a *Prohungarites* fauna, which, in turn, is underlain by a *Columbites* fauna and this by an *Owenites* fauna. The

Tirolites Zone of Smith (1932) is of only local importance and not equivalent to the fauna of the Werfen Formation (see p. 342).

We thus have a sequence of two faunas (*Columbites* and *Prohungarites*) above the mid-Scythian *Owenites* Zone in southeast Idaho, Ellesmere Island, and the Primorye Region and in northern Siberia. However, in China, West Pakistan, and Afghanistan, wherever we have stratigraphic control, the late Scythian *Subcolumbites* or *Prohungarites* fauna lies directly above *Owenites* Zone faunas. This raises a question as to the relationships of the *Columbites* fauna and its independence as a zonal entity.

The *Columbites* fauna and its equivalents are known from southeast Idaho, the Primorye Region and northern Siberia. There are 21 genera of ammonoids in one or another of these three main faunas. The largest number of genera (15) comprise the *Columbites* fauna of southeast Idaho. The Primorye Region contains eight genera and northern Siberia six genera at this horizon. Of the total of 21 genera, only two are restricted to this horizon. Two genera are also present in earlier horizons, seven genera are present in both older and younger horizons, and ten genera are also present in younger horizons. There are no species in common in the faunas assigned to the *Columbites* Zone and those assigned to the *Prohungarites* Zone, but the ten genera in common include such late Scythian members as *Procolumbites*, *Pseudoceltites*, *Svalbardiceras*, *Metadagnoceras*, *Nordophiceras*, *Keyserlingites*, *Olenekites*, *Hellenites*, *Dalmatites*, and *Ussurites*.

The faunas assigned to the *Columbites* Zone clearly are intimately related to those assigned to the *Prohungarites* Zone and are quite distinct from the faunas of the *Owenites* Zone. Zakharov (1966) expressed this relationship by treating the two faunas as subzones of a single late Scythian Zone. There is no question but that this suggestion has merit. However, at a species level, these two successive faunas are very dis-

tinct. The bothersome factor is the absence of the *Columbites* Zone in Tethys. This, however, may be due more to preservation than to anything else. Only eight areas within Tethys have yielded late Scythian faunas. The *Subcolumbites* faunas of Albania and Chios are isolated, without other Scythian faunas above or below. The Werfen fauna and that from the Mangyshlak Peninsula are from semi-isolated embayed regions along the northern margin of Tethys and contain a large percentage of endemic genera and species and are the youngest Scythian ammonoid faunas in their respective areas. The Kashmir record is based on specimens found as float. There are thus only two areas within Tethys where a sequence of two ammonoid zones, *Prohungerites* over *Owenites*, is known. These occur at Kotal-e-Tera, Afghanistan, and in the Salt Range and Surghar Range of West Pakistan. At Kotal-e-Tera the Scythian comprises approximately 90 feet of limestone and dolomite of which 75 feet includes an *Owenites* fauna and the upper 15 feet contains a *Prohungerites* Zone fauna. Ammonoids are abundant and fairly well preserved in the *Owenites* Zone, but the fossils from the *Prohungerites* Zone are neither common nor well preserved. In the Salt Range and Surghar Range of West Pakistan the *Prohungerites* Zone is thought to comprise all of the Narmia Member of the Mianwali Formation (Kummel, 1966). Fossils in the Narmia Member are very scarce and not well preserved. The lowest units of the Narmia Member, which includes the Bivalve Limestone of Waagen (1895), contain *Nordophraceras planorbis* (Waagen) and *Xenoceltites sinuatus* (Waagen). These two species could possibly be of *Columbites* Zone age, but because of scarcity and generally poor preservation of the Narmia Member fossils one cannot be sure.

A new area of Permian and Triassic outcrops has been reported by Sokolov and Shah (1965) around Ghazaband Pass, Quetta District, West Pakistan. The pres-

ence of the Scythian in this region is based on a single specimen identified by Mr. A. N. Fatmi of the Geological Survey of Pakistan as *Columbites* sp. The formation which yielded this specimen comprises 300–500 meters of shale with thin interbeds of limestone. It is unfortunate that this specimen has neither been described nor illustrated.

The absence of a *Columbites* Zone fauna in Kwangsi, China, may be due to facies differences or possibly to insufficient field studies. There is obviously a great need for more data, but on the basis of the picture developed here, I advocate considering the *Columbites* and *Prohungerites* Zones as closely related but distinct; the absence of the *Columbites* fauna in Tethys and south China is most likely due to collection failure and/or adverse facies for preservation.

The nomenclature of these late Scythian zones presents problems. The *Columbites* Zone seems fairly well established. The name-giving species, *Columbites parisiensis*, is present at the type locality in Paris Canyon, southeast Idaho, in the Primorye Region, and possibly in Arctic Canada. The presence of *Columbites parisiensis* in the Primorye Region makes it difficult to understand why Zakharov (1966) selected a different species to identify this zone. *Columbites* is not present in northern Siberia, but the genera and species of Popov's *Dieneroceras* Zone are very close to those in the *Columbites* fauna of south-east Idaho.

The naming of the Scythian post-*Columbites* Zone has not been settled to everyone's satisfaction, mainly because of erroneous views concerning composition of the faunas and their correlation. Spath (1934) was the first to clearly recognize the need for a unit (or zone) above that of *Columbites*. For this upper unit he introduced the Prohungeritan Division, with the following comment: "On the other hand, the uppermost beds of the Eo-Trias are as yet very incompletely known, and

the use of the term Prohungaritan (or Olenikitan) is provisional, for the *Olenikites* especially may yet be found to belong to the Columbitan, together with *Keyserlingites*, although its derivative *Durgaites* is a characteristic element of the Lower Anisian" (Spath, 1934:32, 33). We now have a much larger fund of data than was available to Spath. There is no longer any question as to the need for an additional zone above that of *Columbites*, but at the same time I conclude that only one such zone is present world wide. To be sure, there are areas where several local zones are present, e.g. Mangyshlak Peninsula, but these are only parts of a global zone.

There is only one species of ammonite in the late Scythian that is world wide in distribution—*Pseudosageceras multilobatum*. However, a number of genera and even species have very widespread distribution. Such forms and their patterns of overlapping associations provide the key for definition of a global late Scythian Zone. Within Tethys there is a fairly homogeneous fauna characterized by such forms as *Subcolumbites*, *Albanites*, and *Prohungarites*. These Tethyan faunas have a high degree of similarity with faunas from the western and eastern Pacific regions. There is much less similarity with the faunas of the circum-Arctic region. However, the presence of several genera which are particularly characteristic of the circum-Arctic region within faunas of the western and eastern Pacific and in Tethys offers the opportunity to make a correlation. For this latest zone of the Scythian I feel we should retain the name *Prohungarites* as originally, though tentatively, suggested by Spath (1934). There is surely much that remains to be known about late Scythian ammonites, but on the basis of the available data, I see no need to introduce changes in Spath's nomenclature. The genus *Prohungarites* is now known to be widely distributed in the Tethyan, Pacific and Arctic realms. The large number of forms associated with *Prohungarites* makes correlation of faunas

in which it is not present relatively easy.

Wright (in Ager and Nichols, 1963) has suggested an interesting base upon which to develop a logical picture of the spatial relationships of the many late Scythian faunas now known. Evidence is mounting that ammonites were gregarious and perhaps had distinct paths of migration, possibly as part of the breeding process. The modification and superimposing of gregarious swarms could lead to the kinds of assemblages that are encountered in these late Scythian faunas. The faunas of the Werfen Formation and the Mangyshlak Peninsula, with their large component of endemic genera and species, are clearly geographic isolates developed in embayments off the margin of Tethys.

Few precise radiometric dates are available for the Triassic (Harland, et al., 1964). Holmes (1959) assigned a period of 45 million years, and Kulp (1961) 49 million years to the Triassic; thus it seems reasonable to conclude that the Scythian had a duration of possibly 7 to 10 million years. Within the Scythian there exist most probably only five or six world-wide zones. This suggests a duration of approximately 1 to 2 million years for each zone.

A few comments are appropriate regarding the use of Scythian as the stage name for the Lower Triassic in light of recent attempts to introduce other names. The history of the name Scythian has already been discussed (p. 313). The name has had general acceptance as the stage name for the Lower Triassic ever since the term was introduced in 1895. The term is well entrenched in the paleontological literature, works on regional geology, text-books, etc. In recent years proposals have been made to abandon the term Scythian and replace it with two or four new stage names. Some of these proposals were clearly intended for use within a particular country, others were hopefully proposed for wider application. For instance, in New Zealand there has been a general abandonment of European stage names, and a new classification

specifically adapted to the New Zealand stratigraphic panorama is used. The local stages are then correlated with the European stages. Ammonites are not common in Triassic formations of New Zealand; pelecypods and brachiopods are more common and play a greater role in the definition of the local stages. It should be noted that the Triassic ammonites, known to date, are genera common to faunas of Tethys and the circum-Pacific region. A somewhat similar approach to Triassic chronology has been proposed by Ichikawa (1950, 1956) for Japan. This system of classification has not been generally adopted in Japan.

Kiparisova and Popov (1956, 1961, 1964) in a series of papers have proposed abandonment of Scythian as the stage name for the Lower Triassic and the substitution of two new stage names, the Indian and the Olenekian. The lower of these stages, the Indian, derives its name from the Indus River, and the upper, the Olenekian, from the Olenek beds of the Olenek River region, northern Siberia. These two stages are equivalent to the Lower Eo-Trias and Upper Eo-Trias of Spath (1934); the boundary of the stages was placed between the Flemingian and Owenian divisions of Spath. In a later contribution on this subject Kiparisova and Popov (1964) altered the spelling of their stage names to Indus and Olenek and lowered the boundary between the zones. These authors concluded that the ammonites of the *Flemingites flemingianus* Zone are really equivalent to the *Owenites* Zone; thus the upper zone for the Indus stage at its type locality in the Salt Range is the zone of *Koninckites volutus* which these authors placed within the *Gyronites* Zone.

The most recent contribution of new stage names for the Lower Triassic of Canada is by E. T. Tozer (1965b). This author proposes for use in Canada four stages: Griesbachian, Dienerian, Smithian, Spathian. Tozer had the cooperation of the Canadian Permanent Committee on Geo-

graphical Names in establishing names of creeks in Arctic Canada after these prominent Triassic paleontologists. The type areas of these new stages are based on sequences in Ellesmere and Axel Heiberg Islands.

The presumed justification for establishing these new stage names is to clarify communication. Local stage names under certain circumstances are useful. However, they tend to be based on incomplete data and approached from a provincial point of view. We need only look back at the history of development of the geological time scale to see the bad effects of the proliferation of stage names for certain systems and the resultant confusion. One would think we had reached a stage of maturity in the science where repetition of this sort of thing would not take place.

SUMMARY OF PROHUNGARITES ZONE AMMONOIDS

The ammonoids of the *Prohungarites* Zone, as here understood, comprise 65 genera with 154 species (Table 7). Of the total number of genera, 42 are confined to this zone, 20 genera are known to range up from the preceding *Columbites* and *Owenites* zones, one genus is known from both older and younger horizons, and 2 genera are also present in the overlying Anisian. The geographic distribution of the genera is summarized in Table 8. Twenty-four genera, or 36.9 percent of the fauna, are confined to a single locality or region; 10 genera, or 15.4 percent of the fauna are known from two localities. Thus 52.2 percent of the total fauna of 65 genera are known from only one or two localities. On the other hand, only 10 genera, or 15.4 percent, are known from 6 to 11 localities or regions. The degree of geographic restriction of genera is of particular interest. There are 24 genera endemic to the Tethyan region, that is, known only from one or two localities within Tethys. However, the western Pacific, eastern Pacific, and Arctic faunas have only two endemic genera each.

TABLE 7. Continued

[illegible]

TABLE 7. Continued

[illegible]

TABLE 7. Continued

	Werfen Formation (Alps to Bulgaria)	Albania (<i>Subcolumbites</i> fauna)	Chios (<i>Subcolumbites</i> fauna)	Mangyshlak Peninsula	Afghanistan (<i>Subcolumbites</i> fauna)	Salt & Surghar Ranges West Pakistan	Kashmir (<i>Prohungarites</i> fauna)	Timor (<i>Prohungarites</i> fauna)	New Zealand	Kwangsi, China (<i>Subcolumbites</i> fauna)	Japan (<i>Subcolumbites</i> fauna)	Primorye Region (<i>Subcolumbites</i> fauna)	Olenek Region (<i>Olenckites</i> fauna)	Spitsbergen (<i>Kryserlingites</i> fauna)	Ellesmere Island (<i>Kryserlingites</i> fauna)	British Columbia (Toad-Grayling Fm.)	Providence Range California	Humboldt Range Nevada	Tobin Range Nevada	Confusion Range Nevada	Southeast Idaho (<i>Prohungarites</i> fauna)	Range of genera and species
Tirolitidae																						
<i>Tirolites</i>						×														×		c
<i>idrianus</i>	×	×																				×
<i>cassianus</i>	×			×																		×
<i>cingulatus</i>	×																					×
<i>rossicus</i>				×																		×
<i>impolitius</i>				×																		×
<i>morpheos</i>													×									×
Diaplococeras																						×
<i>liccanum</i>	×																					×
<i>connectens</i>	×																					×
Bittnerites																						×
<i>bittneri</i>	×																					×
Doricranites																						×
<i>bogdoanus</i>				×																		×
<i>acutus</i>				×																		×
Dinaritidae																						
<i>Dinarites</i>																						×
<i>dalmatinus</i>	×		×																			×
<i>carniolicus</i>	×																					×
<i>liatsikisi</i>			×																			×
<i>undatus</i>				×																		×
<i>Hololobos</i>																						×
<i>monoptychus</i>	×																					×
<i>Pseudodinarites</i>																						×
<i>mohamedanus</i>	×																					×
Hellenitidae																						
<i>Helleuites</i>																						e
<i>praematurus</i>		×	×							×												×
<i>radiatus</i>			×							×									×			×
Beyrichitidae																						
<i>Beyrichites</i>																						l
<i>laurae</i>			×																			×
Gymnitidae																						
<i>Eogymnites</i>																						×
<i>arthaberi</i>		×																				×
Hungaritidae																						
<i>Prohungarites</i>						×																×
<i>crassiplicatus</i>								×														×
<i>tuberculatus</i>								×														×
<i>middelmissii</i>							×															×
<i>carinatus</i>				×																		×
<i>mckelvei</i>																						×
<i>gutstadti</i>																					×	×
<i>Dalmatites</i>																						e
<i>morlaccus</i>	×																					×
Ussuritidae																						
<i>Eophyllites</i>																						×
<i>dieneri</i>		×	×																			×
<i>orientalis</i>								×														×
<i>amurensis</i>												×										×
<i>Palaeophyllites</i>												×										×
<i>steinmanni</i>			×					×														×
<i>Ussurites</i>																						l
<i>sieveri</i>																		×				×
<i>hoesi</i>																			×			×
<i>Leiciophyllites</i>					×													×				l
<i>variabilis</i>		×	×																×			×
<i>radians</i>				×								×										×
<i>serpentinus</i>										×												×
<i>admaris</i>												×										×
<i>marinitinus</i>												×										×

TABLE 8. GEOGRAPHIC DISTRIBUTION OF AMMONOID GENERA OF *PROHUNGARITES* ZONE IN TERMS OF NUMBERS OF LOCALITIES OR REGIONS IN WHICH EACH GENUS IS PRESENT.

Number of Localities	Number of Genera	Percentage of Total Fauna
1	24	36.9
2	10	15.3
3	6	9.2
4	8	12.3
5	7	10.7
6	5	7.7
7	2	3.1
8	0	0
9	1	1.6
10	1	1.6
11	1	1.6

Within the Tethyan region the highest degree of endemism is found in the fauna of the Werfen Formation, with 6 genera out of a total of 11 restricted to that formation. A seventh genus, *Dalmatites*, is in the *Prohungarites* Zone, restricted to the Werfen Formation, but another species of this genus occurs in the underlying *Columbites* Zone in southeast Idaho. *Diaplococeras* is represented by two species, but the other endemic genera by only a single species each. Two of the species are known from only a single specimen each and the others from very few specimens.

The *Subcolumbites* fauna of Albania includes four endemic genera—*Protropites*, *Arianites*, *Beatites*, and *Eogymnites*; *Protropites* is a fairly common member of that fauna but the other three genera are known only from a single specimen each. The *Subcolumbites* fauna of Chios also contains four endemic genera—*Chiotites*, *Chioceras*, *Meropella*, and *Beyrichites*. Among these four genera, *Chiotites* is abundantly represented in the Chios fauna, but the other three genera are known from only three or four specimens each. In the Mangyshlak Peninsula the late Scythian fauna includes three endemic genera—*Procolumbites*, *Eukashmirites*, and *Doricranites*; of these, *Doricranites* appears to be by far the most common form. In the Salt Range the

Prohungarites Zone contains fragmentary specimens of *Anakashmirites*, a genus not recorded from any other locality in this zone.

Within the western Pacific realm there are two endemic genera—*Paradinarites* and *Parussuria*—from the *Subcolumbites* faunas of Kwangsi, China. In the eastern Pacific realm there are only two endemic genera in the *Prohungarites* Zone faunas. *Monocanthites* is known only from late Scythian strata in British Columbia, and *Ussurites* only from Nevada and Utah. *Ussurites* is a fairly common Anisian genus, but the species recorded here are the first from the late Scythian. In the Arctic realm there are two endemic genera, *Boreomekoceras* and *Arctotiolites*, both known from the Olenek fauna.

In evaluating the degree of similarity of these late Scythian faunas of the *Prohungarites* Zone, Simpson's index of faunal resemblance is useful (Simpson, 1943, 1947, 1953). This index is symbolized as $100 C/N$, in which C stands for the number of taxonomic units common to two faunas, and N is the total number of genera in the smaller of the two. The number of genera in common and the index of correlations, on the basis of genera of these faunas attributed to the *Prohungarites* Zone, are given in Tables 9 and 10.

It is recognized that the composition of any of these faunas is influenced by factors of preservation, collection techniques, and facies. Evaluation of the relative significance of these factors in regard to each of the faunas is most difficult. The *Subcolumbites* faunas of Albania and Chios appear to have been thoroughly collected. This applies also to the fauna of the Werfen Formation; however, in this case more stratigraphic data are desirable. It is my impression from the literature that the Mangyshlak fauna contains more genera and species than those described to date. The Afghanistan and Salt Range faunas are known from small collections, mainly of poorly preserved specimens. The chance

TABLE 9. SUMMARY CHART OF NUMBERS OF GENERA IN COMMON BETWEEN FAUNAS OF THE *PROHUNGARITES* ZONE FROM NINETEEN LOCALITIES OR REGIONS.

	Werfen Fm.	Albania	Chios	Mangyshlak	Afghanistan	Salt & Surghar Ranges	Kashmir	Timor	New Zealand	Kwangsi, China	Japan	Primorye Region	Olenek	Spitsbergen	Ellesmere Island	British Columbia	Tobin Range	Confusion Range	Southeast Idaho
Werfen Fm.	11	1	1	3	0	2	0	0	0	0	0	0	1	0	0	0	1	1	1
Albania	1	28	19	7	8	6	0	10	1	13	1	11	4	0	0	6	8	2	3
Chios	1	19	27	7	7	3	0	9	0	10	1	9	4	0	1	5	8	1	3
Mangyshlak	3	7	7	15	4	5	1	4	0	3	0	4	3	0	1	1	4	3	4
Afghanistan	0	8	7	4	11	5	0	5	0	5	1	6	3	1	1	3	4	1	3
Salt & Surghar Ranges	2	6	3	5	5	13	11	5	0	5	0	4	5	2	1	3	3	2	4
Kashmir	0	0	0	1	0	1	1	1	0	0	0	0	0	0	0	0	0	0	1
Timor	0	10	9	4	5	5	1	12	0	4	0	4	2	0	0	2	3	1	2
New Zealand	0	1	0	0	0	0	0	0	1	1	0	1	1	0	0	1	0	0	0
Kwangsi, China	0	13	10	3	5	5	0	4	1	16	1	8	4	0	0	4	6	0	2
Japan	0	1	1	0	1	0	0	0	0	1	1	1	0	0	0	0	1	0	0
Primorye Region	0	11	9	4	6	4	0	4	1	8	1	11	3	0	0	3	5	1	2
Olenek	1	4	4	3	3	5	0	2	1	4	0	3	15	2	2	4	1	2	5
Spitsbergen	0	0	0	0	1	2	0	0	0	0	0	0	2	2	2	2	0	0	2
Ellesmere Island	0	0	1	1	1	1	0	0	0	0	0	0	2	2	4	3	0	0	2
British Columbia	0	6	5	1	3	3	0	2	1	4	0	3	4	2	3	11	2	0	3
Tobin Range	1	8	8	4	4	3	0	3	0	6	1	5	1	0	0	2	10	2	3
Confusion Range	1	2	1	3	1	2	0	1	0	0	0	1	2	0	0	0	2	4	1
Southeast Idaho	1	3	3	4	3	4	1	2	0	2	0	2	5	2	2	3	3	1	9
Total Genera	11	28	27	15	11	13	1	12	1	16	1	11	15	2	4	11	10	4	9

of ever uncovering larger and better preserved faunas from these localities is not good. The Timor fauna is known from isolated blocks mainly from a single locality. It is apparent that Welter's (1922) monograph has by no means dealt exhaustively with this fauna. New collecting on Timor is badly needed. The *Prohungerites* Zone faunas of New Zealand and Japan consist of a single species each. In these two areas facies and preservations have been the most severe limiting factors. The *Subcolumbites* fauna of Kwangsi, China, appears to have been adequately collected. The faunas of the Primorye Region and northern Siberia have been collected extensively but there is urgent need of more detailed stratigraphic and geographic data.

I have the impression from the literature that ammonites are not abundant in these regions. Neither are ammonites of the *Prohungerites* Zone abundant in Ellesmere Island or in British Columbia. In these two areas logistical difficulties further complicate the problem and offer perhaps an explanation for the small size of the known faunas. The fauna of the Tobin Formation has been well collected, but I am sure that more search will yield additional specimens. The same applies to the fauna from Hammond Creek in southeast Idaho.

Considering all these factors, one should use some restraint in evaluating the faunal indices of Table 10; this of course applies more to the smaller faunas. If one assumes that contiguous faunas within a geologic

TABLE 10. INDEX OF FAUNAL SIMILARITY AT A GENERIC LEVEL FOR NINETEEN AMMONOID FAUNAS OF THE *PROHUNGARITES* ZONE.

	Werfen Fm.	Albania	Chios	Mangyshlak	Afghanistan	Salt & Surghar Ranges	Kashmir	Timor	New Zealand	Kwangsi, China	Japan	Primorye Region	Olenek	Spitsbergen	Ellesmere Island	British Columbia	Tobin Range	Confusion Range	Southeast Idaho
Werfen Fm.	100	9	9	27	0	18	0	0	0	0	0	0	9	0	0	0	11	25	11
Albania	9	100	70	46	72	46	0	83	100	81	100	100	26	0	0	54	80	50	33
Chios	9	70	100	46	63	23	0	75	0	62	100	81	26	0	25	45	80	25	33
Mangyshlak	27	46	46	100	36	38	100	33	0	20	0	36	20	0	25	9	40	75	44
Afghanistan	0	72	63	36	100	45	0	45	0	45	100	54	27	50	25	27	40	25	33
Salt & Surghar Ranges	18	46	23	38	45	100	100	41	0	38	0	36	38	100	25	27	30	50	44
Kashmir	0	0	0	100	0	100	100	100	0	0	0	0	0	0	0	0	0	0	100
Timor	0	83	75	33	45	41	100	100	0	33	0	36	16	0	0	18	30	25	22
New Zealand	0	100	0	0	0	0	0	0	100	100	0	100	100	0	0	100	0	0	0
Kwangsi, China	0	81	62	20	45	38	0	33	100	100	100	72	26	0	0	26	60	0	22
Japan	0	100	100	0	100	0	0	0	0	100	100	100	0	0	0	0	100	0	0
Primorye Region	0	100	81	36	54	36	0	36	100	72	100	100	27	0	0	27	50	25	22
Olenek	9	26	26	20	27	38	0	16	100	26	0	27	100	100	50	36	10	50	55
Spitsbergen	0	0	0	0	50	100	0	0	0	0	0	0	100	100	100	100	0	0	100
Ellesmere Island	0	0	25	25	25	25	0	0	0	0	0	0	50	100	100	75	0	0	50
British Columbia	0	54	45	9	27	27	0	18	100	26	0	27	36	100	75	100	20	0	33
Tobin Range	11	80	80	40	40	30	0	30	0	60	100	50	10	0	0	20	100	50	33
Confusion Range	25	50	25	75	25	50	0	25	0	0	0	25	50	0	0	0	50	100	25
Southeast Idaho	11	33	33	44	33	44	100	22	0	22	0	22	55	100	50	33	33	25	100
Total Genera	11	28	27	15	11	13	1	12	1	16	1	11	15	2	4	11	10	4	9

province reflect better the actual composition of the fauna, a computation of faunal resemblance between geologic provinces could be more meaningful. Scythian paleogeography is characterized by Tethys and by marginal geosynclines on the continents surrounding the Pacific and Arctic oceans. The Spitsbergen, Ellesmere Island, and northern Siberian (Olenek) faunas thus fall within an Arctic province. The eastern Pacific province includes the faunas from British Columbia, Nevada, Utah, and southeast Idaho. The western Pacific province includes the faunas from the Primorye Region, China, Japan, Timor, and New Zealand. The Tethyan province includes the Kashmir, West Pakistan, Afghanistan, Mangyshlak, Chios, Albania, and Werfen For-

mation faunas. The index of correlation of the faunas between these geologic provinces is given in Table 11. The Tethyan province has the largest fauna in total numbers of genera, and the largest number of genera are endemic to that province. In contrast, the Arctic province has the smallest total number of genera, while the eastern and western Pacific provinces are intermediate and have the same number of genera. There is a high degree of correlation of the western and eastern faunas with those of Tethys; the Arctic faunas show a lesser degree of correlation. It is of interest to note the relatively low degree of correlation between the Arctic province and the western Pacific; the correlation between the Arctic and the eastern Pacific provinces

TABLE 11. INDEX OF FAUNAL SIMILARITY AT A GENERIC LEVEL FOR AMMONOID FAUNAS OF THE *PROHUNGARITES* ZONE BETWEEN THE MAJOR PALEOGEOGRAPHIC PROVINCES.

	Tethys	W. Pacific	E. Pacific	Arctic
Tethys	100.0	92.0	84.0	68.7
W. Pacific	92.0	100.00	48.0	31.2
E. Pacific	84.0	48.0	100.00	56.3
Arctic	68.7	31.2	56.3	100.0
Total genera	57	25	25	16
Number of endemic genera	24	2	2	2
Percentage of endemic genera	42.1	8.0	8.0	12.5

(56 percent) is approximately twice as good. At the same time the correlation between the eastern and western Pacific provinces is only 48 percent.

Only two of the 65 genera of the *Prohungerites* Zone, *Pseudosageceras* and *Prospiringites*, are present in all four of the main geologic provinces. There are, however, ten additional genera which occur in the Tethyan, western Pacific, and eastern Pacific provinces:

<i>Cordillerites</i>	<i>Subcolumbites</i>
<i>Hemilecanites</i>	<i>Metadagnoceras</i>
<i>Procarinites</i>	<i>Hellenites</i>
<i>Arnautoceltites</i>	<i>Prohungerites</i>
<i>Isculitoides</i>	<i>Leiophyllites</i>

Of this list of 10 genera, 7 are confined to the *Prohungerites* Zone, 2 are known from older horizons, and one is known from younger horizons.

Discounting for the moment the endemic genera within each province, the above widely distributed genera constitute 33 percent of the Tethyan fauna and 48 percent of the western and eastern Pacific faunas.

The faunas of the Arctic regions are more distinctive than the index of faunal similarities tends to suggest. The Arctic province includes 16 genera, of which only two (*Boreomeekoceras* and *Arctotiolites*) are endemic. Whereas all but two of the genera in the Arctic province are present in one or more of the other three major geologic provinces, there are significant dif-

TABLE 12. GEOGRAPHIC DISTRIBUTION OF AMMONOID SPECIES OF *PROHUNGARITES* ZONE IN TERMS OF NUMBER OF LOCALITIES OR REGIONS IN WHICH A SPECIES IS PRESENT.

Number of Localities	Number of Species	Percentage of Total Fauna
1	117	75.9
2	23	14.9
3	8	5.2
4	2	1.3
5	2	1.3
7	1	0.6
10	1	0.6

ferences in the relative representation of genera within this and the other provinces. The most characteristic and abundant genera in the Arctic fauna are *Svalbardiceras*, *Sibirites*, *Keyserlingites*, and *Olenekites*. Each of these genera is represented outside of the Arctic province by few species and specimens. *Svalbardiceras* is also known from a few fragmentary specimens in the Salt Range and in southeast Idaho. *Sibirites* is also known from only a few small specimens in the *Subcolumbites* fauna of Chios. Outside the Arctic region, *Keyserlingites* is known in the Tobin Formation of Nevada, the Thaynes Formation of southeast Idaho, and at Kotal-e-Tera, Afghanistan. Finally, *Olenekites* is known from only a few specimens in southeast Idaho and on the Mangyshlak Peninsula. In contrast to the sparse representation of these genera, in terms of numbers of localities represented and numbers of specimens outside of the Arctic province, they are widespread and common elements of the Arctic fauna.

Zenoites was first recognized in the *Subcolumbites* fauna of Chios and is now known also from Ellesmere Island. Likewise, *Proptychitoides* is a very common Tethyan form, now known to be represented by one specimen in northern Siberia. In contrast, *Prospiringites* is quite common in the eastern and western Pacific realms but is relatively rare or uncommon in Tethys and the Arctic province.

An analysis of the *Prohungerites* Zone

TABLE 13. SUMMARY CHART OF NUMBERS OF SPECIES IN COMMON BETWEEN THE FAUNAS OF THE *PROHUNGARITES* ZONE FROM NINETEEN LOCALITIES OR REGIONS.

	Werfen Fm.	Albania	Chios	Mangyshlak	Afghanistan	Salt & Surghar Ranges	Kashmir	Timor	New Zealand	Kwangsi, China	Japan	Primorye Region	Olenek	Spitsbergen	Ellesmere Island	British Columbia	Tobin Range	Confusion Range	Southeast Idaho
Werfen Fm.	15	1	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Albania	1	34	24	3	4	2	0	6	0	5	1	2	1	0	0	1	1	1	2
Chios	1	24	40	3	4	2	0	6	0	7	1	2	1	0	0	1	2	1	2
Mangyshlak	2	3	3	19	3	2	0	3	0	1	0	1	1	0	0	0	1	1	0
Afghanistan	0	4	4	3	4	2	0	3	0	2	1	1	1	0	0	0	1	1	0
Salt & Surghar Ranges	0	2	2	2	2	4	0	2	0	1	0	1	1	0	0	0	1	1	0
Kashmir	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Timor	0	6	6	3	3	2	0	13	0	2	0	1	1	0	0	0	1	1	0
New Zealand	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Kwangsi, China	0	5	7	1	2	1	0	2	0	22	1	0	0	0	0	1	1	0	0
Japan	0	1	1	0	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0
Primorye Region	0	2	2	1	1	1	0	1	0	0	0	14	1	0	0	1	1	1	0
Olenek	0	1	1	1	1	1	0	1	0	0	0	1	18	2	1	2	1	1	0
Spitsbergen	0	0	0	0	0	0	0	0	0	0	0	0	2	3	1	1	0	0	0
Ellesmere Island	0	0	0	0	0	0	0	0	0	0	0	0	1	1	4	1	0	0	0
British Columbia	0	1	1	0	0	0	0	0	0	1	0	1	2	1	1	11	0	0	0
Tobin Range	0	1	2	1	1	1	0	1	0	1	0	1	1	0	0	0	9	1	0
Confusion Range	0	1	1	1	1	1	0	1	0	0	0	1	1	0	0	0	1	3	0
Southeast Idaho	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
Total Species	15	34	40	19	4	4	1	13	1	22	1	14	18	3	4	11	9	3	7

fauna at the generic level shows considerable similarity within and between the major geologic provinces. At the species level, as one would expect, there is a greater degree of endemism, that is, species known from a single region. Table 12 summarizes the geographic distribution of the species known from the *Prohungarites* Zone. It is impressive to note that approximately 75 percent of the species are known from only a single locality or region and only about 8 percent are known from 3 to 8 localities. The numbers of species in common between the various localities and regions are tabulated in Table 13, and the index of correlation (percent) in Table 14. In general there are very low or zero indices of correlation. It is impressive, how-

ever, to see the very high correlation between the *Subcolumbites* faunas of Albania and Chios; lesser but still significantly high correlations exist between the Albanian and Chios faunas and those of Timor and China. The main aspect of the chart is that there is a higher degree of correlation between localities within a geologic province than there is between different provinces.

In collecting from most ammonitiferous deposits it is a common experience that a few genera and species are overwhelmingly predominant, a few species are represented by modest numbers, and a group of species is represented by only one or two specimens each, even after extensive collecting. Even though there are multiple factors which

TABLE 14. INDEX OF FAUNAL SIMILARITY AT THE SPECIES LEVEL FOR NINETEEN AMMONOID FAUNAS OF THE *PROHUNGARITES* ZONE.

	Werfen Fm.	Albania	Chios	Mangyshlak	Afghanistan	Salt & Surghar Ranges	Kashmir	Timor	New Zealand	Kwangsi, China	Japan	Primorye Region	Olenek	Spitsbergen	Ellesmere Island	British Columbia	Tobin Range	Confusion Range	Southeast Idaho
Werfen Fm.	100	6	6	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Albania	6	100	70	15	100	50	0	46	0	22	100	14	5	0	0	9	11	33	28
Chios	6	70	100	15	100	50	0	46	0	31	100	14	5	0	0	9	22	33	28
Mangyshlak	13	15	15	100	75	50	0	23	0	5	0	7	5	0	0	0	11	33	0
Afghanistan	0	100	100	75	100	50	0	25	0	50	100	25	25	0	0	0	25	25	0
Salt & Surghar Ranges	0	50	50	50	50	100	0	50	0	25	0	25	25	0	0	0	25	33	0
Kashmir	0	0	0	0	0	0	100	0	0	0	0	0	0	0	0	0	0	0	0
Timor	0	46	46	23	75	50	0	100	0	15	0	7	7	0	0	0	11	33	0
New Zealand	0	0	0	0	0	0	0	0	100	0	0	0	0	0	0	0	0	0	0
Kwangsi, China	0	22	31	5	50	25	0	15	0	100	100	0	0	0	0	9	11	0	0
Japan	0	100	100	0	100	0	0	0	0	100	100	0	0	0	0	0	0	0	0
Primorye Region	0	14	14	7	25	25	0	7	0	0	0	100	7	0	0	9	11	33	0
Olenek	0	5	5	5	25	25	0	7	0	0	0	7	100	66	25	18	11	33	0
Spitsbergen	0	0	0	0	0	0	0	0	0	0	0	0	66	100	33	33	0	0	0
Ellesmere Island	0	0	0	0	0	0	0	0	0	0	0	0	25	33	100	25	0	0	0
British Columbia	0	9	9	0	0	0	0	0	0	9	0	9	18	33	25	100	0	0	0
Tobin Range	0	11	22	11	25	25	0	11	0	11	0	11	11	0	0	0	100	33	0
Confusion Range	0	33	33	33	25	33	0	33	0	0	0	33	33	0	0	0	33	100	0
Southeast Idaho	0	28	28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	100
Total Species	15	34	40	19	4	4	1	13	1	22	1	14	18	3	4	11	9	3	7

can and do influence preservation, I believe it reasonable to assume that the number of specimens of a species represented in a well collected fauna does reflect the relative abundance of the species. If one accepts this assumption, it makes possible a further evaluation of the composition of the various faunas of the *Prohungarites* Zone and changes of abundance within the various populations.

Data on the total number of specimens and number of specimens per species for nine faunas are given on Table 3. The collections from the *Subcolumbites* faunas of Albania and Chios are by far the largest. The five commonest species in the *Sub-*

columbites fauna of Albania in order of abundance are:

Subcolumbites perrinismithi
Procarinites kokeni
Isculitoides originis
Protropites hilmi
Preukites malsorensis

The 9 species in the Chios fauna that are represented by 50 or more specimens in order of abundance are:

Isculitoides originis
Procarinites kokeni
Leiophyllites variabilis
Chioceras mitzopouloi
Albanites triadicus
Eophyllites dieneri
Hellenites praematurus
Pseudosageceras albanicum
Subcolumbites perrinismithi

Three of these species (*Isculitoides originis*, *Procarnites kokeni*, *Subcolumbites perrinismithi*) are predominant members in both faunas. *Protropites hilmi* is endemic to Albania, as is *Chioceras mizopouloi* to the Chios fauna. Whereas *Prenekites malsorensis* is predominant in the Albanian fauna, it is represented by only two specimens in the Chios collection; *Hellenites praematurus* is very common in Chios but represented by only two specimens in the Albanian collection. Even though *Leiophyllites variabilis* is not on the list from Albania, it still is quite abundant, with 43 specimens in the collection; the same applies to *Eophyllites dieneri* with 40 specimens.

Subcolumbites is predominant in the Albania, Chios, Primorye, and Tobin Formation faunas. In Albania and Chios the species is *perrinismithi*, in the Primorye Region *multiformis*, and in the Tobin Formation *americanus*. *Subcolumbites* is also known from the Afghanistan and Kwangsi faunas, though in both collections by very few specimens only.

Hellenites is a predominant element only in the Chios fauna; in the Albanian, Kwangsi, and Nevada faunas it is represented by very few specimens. *Procarnites kokeni* occupies a position of predominance in the Albanian, Chios, and Kwangsi faunas. It is known from very few specimens in the Afghanistan, Salt Range, and Timor faunas.

Isculitoides is a predominant element in the Albanian, Chios, and southeast Idaho faunas but has only minor representation in the faunas of Afghanistan, Salt Range, China, Primorye, Nevada, and British Columbia.

Olenekites is a predominant element in the faunas of northern Siberia and Ellesmere Island, modestly represented in the Tobin Formation of Nevada (S.W. Muller, personal communication), and very minor in the faunas of the Mangyshlak Peninsula and southeast Idaho. *Prohungarites* is overwhelmingly the predominant element of the fauna from the Upper Thaynes Formation of southeast Idaho but is apparently

TABLE 15. NUMBER OF SPECIES PER GENUS AMONG GENERA OF AMMONOIDS IN THE PROHUNGARITES ZONE.

Number of Species per Genus	Number of Genera	Percentage of Total Genera
1	29	44.6
2	13	20.0
3	8	12.3
4	5	7.7
5	5	7.7
6	4	6.1
7	1	1.5

only a minor element of the faunas of Timor, Kashmir, and the Mangyshlak Peninsula.

A look at the 11 genera which are represented in the Tethyan, western Pacific and eastern Pacific provinces yields some interesting data. Four of these genera (*Cordillerites*, *Hemilecanites*, *Prosphingites*, and *Metadagnoceras*) are not a common element in any of the faunas from which they are recorded. *Procarnites* and *Hellenites* are very common in one or more localities within Tethys but nowhere else. *Subcolumbites*, *Isculitoides*, and *Arnautoceltites* are predominant elements in one or more faunas in the Tethyan, western Pacific and eastern Pacific provinces. *Prohungarites* is common only in the eastern Pacific and *Leiophyllites* in the western Pacific.

Most genera from the *Prohungarites* Zone, that is, approximately 45 percent, are known from only a single species (Table 15). This for the most part reflects the high number of monotypic genera for this zone. At the same time some genera, for example *Cordillerites*, are widely distributed in three of the major paleogeographic provinces, though represented by a single species only. Only 15 genera, or 23 percent of the total fauna, are represented by four or more species. Eight of these genera with four or more species are among those which are known from at least three of the major paleogeographic provinces. Most of the other genera of this group are conspicuous elements of the faunas of one or two of the major paleogeographic provinces.

PALEOGEOGRAPHIC IMPLICATIONS OF PROHUNGARITES ZONE AMMONOIDS

Interest in paleoclimates has greatly heightened since the introduction of paleomagnetic techniques. In the excellent review on paleomagnetism by Cox and Doell (1960), it was encouraging to read in their summary a statement of the need for more and better paleontological data as a test of the geophysical conclusions now being advocated by many researchers. In the past decade there has been a definite increase in paleontological contributions to the problem of paleoclimates. The question rests on the assumption that temperature is the most significant of the factors that controls the distribution of many organisms. Clear-cut temperature gradients are recognized in the distribution patterns of many modern faunas and floras. The general problem of temperature gradients has been given an excellent review by A. G. Fischer (1960). The most active student of paleontology who has been applying the techniques of faunal gradients to the problem of paleoclimates has been F. G. Stehli. Ample testimony to the complexity of the problem can be seen in the number of enthusiastic rebuttals to many of the interpretations of Stehli and others. Craig (1961) has amply reviewed the techniques and limitations in using fossils for paleoclimatic interpretations. He concludes that (a) "we have insufficient knowledge of, and therefore control over, the variables that can affect the form and distribution of fossils," and (b) "stratigraphic correlation is not yet sufficiently accurate to be certain that we are interpreting paleoclimates of the same geological age" (Craig, 1961:224). Craig emphasizes that these somewhat "pessimistic conclusions" are meant to "sound a cautionary note."

Interpretation of the significance of the geographic distribution of the ammonoids of the *Prohungerites* Zone is handicapped by the sparseness of data from the Southern Hemisphere. There are no late Scythian marine deposits nor faunas as yet identified

from Central and South America. The same applies to all of Africa, Madagascar, Australia, and Antarctica. As stated several times above, the basic paleogeographic pattern of the Scythian is that of Tethys, with circum-Atlantic and circum-Arctic marginal seas. There are no marine late Scythian deposits in the Atlantic basin south of Spitsbergen. This pattern of distribution of the known data precludes any direct comment on the problem of large scale horizontal displacements of continents. It is, however, worthwhile to consider the spatial distribution of the ammonoids of the *Prohungerites* Zone. We are first of all dealing with faunas considered to be part of a single zone that probably had a time duration of one to two million years. Working on a world scale I do not believe we shall be able to resolve our correlations much finer than this. The fact that the Tethyan region has the largest numbers of genera and species, the circum-Arctic region only approximately 30 percent as many, and the western and eastern Pacific areas an intermediate amount could very well reflect a climatic pattern. In addition, carbonate rocks are common in the Tethyan and circum-Pacific regions but are essentially absent in the circum-Arctic region for this segment of time. If one accepts the assumption that the known record to date is a reasonably valid reflection of the extent and diversity of late Scythian faunas, I find it most plausible to see here a true faunal gradient which most probably reflects climate. The data interpreted in this vein are more plausible when compared to the pattern of world continents that exists today than to any of the many and varied alternative maps which have been drawn.

SUMMARY OF COLUMBITES ZONE AMMONOIDS

The *Columbites* Zone is now known from four localities, southeast Idaho, Arctic Canada, Primorye Region, and northern Siberia. A summary list of the species and genera of this zone is tabulated in Table 16.

TABLE 16. SUMMARY TABLE OF GENERA AND SPECIES OF AMMONITES AND THEIR GEOGRAPHIC DISTRIBUTION IN THE *COLUMBITES* ZONE. SYMBOLS USED IN RIGHT HAND COLUMN (RANGE OF GENERA AND SPECIES) ARE AS FOLLOWS: X = PRESENT ONLY AT THIS HORIZON, — = PRESENT IN BOTH YOUNGER AND OLDER HORIZONS, e = PRESENT ALSO IN EARLIER HORIZONS, l = PRESENT ALSO IN LATER HORIZONS.

	<i>Columbites</i> Fauna Southeast Idaho	<i>Dieneroceras</i> Zone Northern Siberia	<i>Neocolumbites</i> Subzone Primorye Region	Range of Genera and Species		<i>Columbites</i> Fauna Southeast Idaho	<i>Dieneroceras</i> Zone Northern Siberia	<i>Neocolumbites</i> Subzone Primorye Region	Range of Genera and Species
Sageceratidae					<i>Metadagnoceras</i>				l
<i>Pseudosageceras</i>				—	<i>micum</i>			X	X
<i>multilobatum</i>	X	X		—	<i>Nordophiceras</i>				l
<i>Cordillerites</i>				—	<i>euomphalus</i>		X		X
<i>angulatus</i>	X			—	<i>alexeevae</i>		X		X
Dieneroceratidae					<i>jacksoni</i>	X			X
<i>Dieneroceras</i>				—	<i>pilatum</i>	X			X
<i>demokidovi</i>		X		X	Prionitidae				
<i>apostolicus</i>	X	X		X	<i>Hemiprionites</i>				e
<i>Subvishniites</i>				—	<i>costatus</i>		X		X
<i>cickitensis</i>		X		X	Sibiritidae				
Xenoceltitidae					<i>Keyserlingites</i>			X	l
<i>Xenoceltites</i>				—	<i>stephensoni</i>	X			X
<i>spencei</i>	X			X	<i>Olenekites</i>			X	l
<i>Prefflorianites</i>				—	Tirolitidae				
<i>montpelierensis</i>	X			X	<i>Tirolites</i>				—
Paranoritidae					<i>harti</i>	X			X
<i>Pseudaspidites</i>				e	<i>smithi</i>	X			X
<i>popovi</i>	X			X	<i>astakhovi</i>	X			X
<i>posterius</i>		X		X	Hellenitidae				
Paranannitidae					<i>Hellenites</i>			X	l
<i>Columbites</i>				X	<i>idahoense</i>	X			X
<i>parisianus</i>	X		X	X	<i>inopinatus</i>			X	X
<i>Procolumbites</i>			X	l	Hungaritidae				
<i>Neocolumbites</i>			X	X	<i>Dalmatites</i>				—
<i>Pseudoceltites</i>				e	<i>kitli</i>	X			X
<i>cheneyi</i>	X			X	Ussuriidae				
Meekoceratidae					<i>Ussurites</i>				l
<i>Svalbardiceras</i>			X	l	<i>mansfieldi</i>	X			X
<i>sheldoni</i>	X			X					

The limited areas from which this fauna is known do not allow the broad synthesis that was possible for the ammonoids of the *Prohungarites* Zone. Most of the pertinent data regarding the ammonoids of this zone and their relationship to the underlying faunas of the *Owenites* Zone and the overlying faunas of the *Prohungarites* Zone have already been discussed in the section on chronology. The relationships of the ammonoid fauna of the *Columbites* Zone to

those of the underlying *Owenites* Zone and the overlying *Prohungarites* Zone are summarized at a generic level on Table 17.

STRATIGRAPHY AND FAUNAS OF THE LATE SCYTHIAN

Ammonoid faunas of late Scythian age are now known from 17 localities or regions (Fig. 1). In this chapter are summarized the stratigraphic and faunal data on each of these occurrences. The discussion first

TABLE 17. TOTAL GENERA AND THEIR RANGES IN THE THREE UPPER ZONES OF THE LATE SCYTHIAN. SYMBOLS USED IN THE FOUR RIGHT HAND COLUMNS ARE AS FOLLOWS: X = PRESENT ONLY AT THIS HORIZON, — = PRESENT IN BOTH YOUNGER AND OLDER HORIZONS, e = PRESENT ALSO IN EARLIER HORIZONS, I = PRESENT ALSO IN LATER HORIZONS.

	Total Genera	Tethys	W. Pacific	E. Pacific	Arctic	X	e	—	I
<i>Prohungerites</i>	65	57	25	25	16	42	20	1	2
<i>Columbites</i>	21		8	15	6	2	2	7	16
<i>Owenites</i>	58	34	43	32	14	38	6	1	13

centers on the Tethyan faunas proceeding from west to east; then the areas in the western Pacific belt are discussed; this leads to the circum-Arctic region, and finally to the east Pacific localities. For each locality that has previously been monographed the original faunal list is given plus a summary list of the species I recognize based on the discussion in the systematic portion of this report.

Albania

One of the most abundant and diverse of late Scythian faunas is that from Këira, Albania. This fauna, originally collected by Dr. Franz Baron Nopcsa and studied by G. Arthaber (1908, 1909, 1911), occurs in a one meter bed of red nodular limestone. There are no other Scythian faunas known in the sequence of strata at Këira. Arthaber recognized in this fauna 59 species, placed in 30 genera; a list of these species is as follows:

- Pseudosageceras drinense* Arthaber
- Sageceras albanicum* Arthaber
- Pronorites triadicus* Arthaber
- Pronorites osmanicus* Arthaber
- Pronorites arbanus* Arthaber
- Hedenstroemia kastrotae* Arthaber
- Hedenstroemia skipetarensis* Arthaber
- Beahtes berthae* Arthaber
- Procamnites kokeni* Arthaber
- Procamnites skanderbegis* Arthaber
- Paranannites mediterraneus* Arthaber
- Proptychites latifimbriatus* de Koninck
- Proptychites krafftii* Arthaber
- Proptychites trigonalis* Arthaber
- Proptychites bertisci* Arthaber
- Proptychites obliqueplicatus* Waagen
- Xenodiscus sulioticus* Arthaber
- Xenaspis mediterranea* Arthaber
- Japanites sugriva* Diener

- Monophyllites dieneri* Arthaber
- Monophyllites pitamaha* Diener
- Monophyllites kingi* Diener
- Monophyllites hara* Diener
- Monophyllites nopcsai* Arthaber
- Lecanites skutarensis* Arthaber
- Lecanites fishtae* Arthaber
- Lecanites niazi* Arthaber
- Lecanites discus* Arthaber
- Ophiceras sakuntala* Diener
- Ophiceras* cfr. *nangaensis* Waagen
- Dagnoceras nopcsanum* Arthaber
- Dagnoceras zappanense* Arthaber
- Dagnoceras terbunicum* Arthaber
- Dagnoceras komanum* Arthaber
- Dagnoceras lejanum* Arthaber
- Meekoceras radiosum* Waagen
- Meekoceras skodrense* Arthaber
- Meekoceras hakki* Arthaber
- Meekoceras mahomedis* Arthaber
- Aspidites hasserti* Arthaber
- Aspidites marginalis* Arthaber
- Tirolites illyricus* Mojsisovics
- Tirolites rectangularis* Mojsisovics
- Prosphingites ali* Arthaber
- Pseudosibirites* cfr. *dichotomus* Waagen
- Protropites hilmi* Arthaber
- Prenkites malsorensis* Arthaber
- Isulites originis* Arthaber
- Styrites lilangensis* Diener
- Columbites europaeus* Arthaber
- Columbites perrinismithi* Arthaber
- Columbites dusmani* Arthaber
- Columbites mirditensis* Arthaber
- Arianites musacchi* Arthaber
- Paragoceras dukagini* Arthaber
- Celtites arnauticus* Arthaber
- Celtites keirensis* Arthaber
- Epiceltites gentii* Arthaber
- (?) *Tropiceltites praematurus* Arthaber

What specimens remain of the Këira collection studied by Arthaber are deposited in the Paleontological Institute, University of Vienna. This collection now consists mainly of the illustrated specimens. The fate of the many unfigured paratypes is



Figure 1. Index map of localities where faunas of *Prohungarites* Zone age have been reported. (1) Upper Thaynes Formation, southeastern Idaho; (2) Upper Thaynes Formation, west-central Utah; (3) Tobin Formation, Tobin Range, Nevada; (4) *Subcolumbites* fauna, Providence Range, southeastern California; (5) Humboldt Range, Nevada; (6) Toad-Grayling Formation, northeastern British Columbia; (7) Upper Scythian of Ellesmere Island and Axel Heiberg Island; (8) Spitsbergen; (9) Olenek-Lena River Basin, Siberia; (10) Okhotsk-Kolyma Land, Siberia; (11) Primorye Region around Vladivostok; (12) Osawa Formation near Sendai, Japan; (13) south Otago, South Island, New Zealand; (14) *Prohungarites* fauna, Nifaeokoko, Timor; (15) *Subcolumbites* fauna, Kwangsi, China; (16) *Prohungarites* fauna, Kashmir, Himalayas; (17) Narmio Member, Mianwali Formation, Salt Range and Surghar Range, West Pakistan; (18) *Subcolumbites* fauna, Kotal-e-Tera, Afghanistan; (19) Tyur-Upa Suite, Mangyshlak Peninsula, Caspian region; (20) *Subcolumbites* fauna of Chios; (21) *Subcolumbites* fauna of Albania; (22) *Tirolites* fauna of Campil Member of Werfen Formation.

unknown, though part or all of them may be in the collection obtained by the British Museum (Natural History) in 1922, by purchase. All of the existing specimens from Albania in these two institutions have been thoroughly studied and are discussed in the systematic part of this paper. Arthaber's illustrations of his species are highly retouched photographs and in many cases quite misleading. Likewise, many of his suture drawings were not as successful as one would like. Unretouched photographs of the primary types and new drawings of many sutures are presented in the systematic chapter.

My own studies of this fauna lead me to conclude that it consists of 32 species, placed in 27 genera. A summary list of the species recognized is given on Table 18. I was unable to evaluate four of Artha-

ber's species: *Lecanites fishtae*, *Lecanites niazi*, *Meckoceras skodrense*, *Aspidites marginalis*. I consider these as unrecognizable species, and thus they are not treated in the taxonomic summary of the fauna.

Chios

The largest and most diverse of any late Scythian ammonite fauna is that from the island of Chios collected by Dr. C. Renz and associates. The collection consists of nearly 2,000 specimens and is deposited in the Natural History Museum, Basel. The ammonites come from hard, red, siliceous limestone; there are no other Scythian faunas known from Chios. The fauna is almost identical to that from Kçira, Albania, which likewise occurs in a hard, red, siliceous limestone. Renz and Renz (1947, 1948) recognized 116 species, subspecies,

TABLE 18. SUMMARY LIST OF SPECIES RECOGNIZED IN THIS REPORT FROM THE SUBCOLUMBITES FAUNAS OF ALBANIA AND CHIOS.

	Alba- nia	Chios		Alba- nia	Chios
<i>Pseudosagecceras multilobatum</i> Noetting		×	<i>Prenkites timorensis</i> Spath		×
<i>Pseudosagecceras drinense</i> Arthaber	×	×	<i>Prenkites helenae</i> Renz and Renz		×
<i>Pseudosagecceras albanicum</i> (Arthaber)	×	×	<i>Protropites hilmi</i> Arthaber	×	
<i>Pseudosagecceras pasquayi</i> Renz and Renz		×	<i>Chioceras mizopouloi</i> Renz and Renz		×
<i>Cordillerites angulatus</i> Hyatt and Smith	×	×	<i>Chioceras nodosum</i> Renz and Renz		×
<i>Dieneroceras mediterranea</i> (Arthaber)	×	×	<i>Arianites musacchi</i> Arthaber	×	
<i>Dieneroceras skutarensis</i> (Arthaber)	×	×	<i>Meropella plejanae</i> Renz and Renz		×
<i>Subtrishumites eweris</i> (Arthaber)		×	<i>Epiceltites genti</i> Arthaber	×	×
<i>Hemilecanites discus</i> (Arthaber)	×	×	<i>Metahedustroemia kastriotae</i> (Arthaber)	×	×
<i>Preflorianites sulioticus</i> (Arthaber)	×	×	<i>Beatites berthae</i> Arthaber	×	
<i>Preflorianites garbinius</i> (Renz and Renz)		×	<i>Dagnoceras nopcsanum</i> Arthaber	×	
<i>Proptychitoides decipiens</i> Spath	×	×	<i>Dagnoceras zappanense</i> Arthaber	×	
<i>Proptychitoides trigonalis</i> (Arthaber)	×	×	<i>Metadagnoceras terbunicum</i> (Arthaber)	×	×
<i>Procarinites kokeni</i> (Arthaber)	×	×	<i>Albanites triadicus</i> (Arthaber)	×	×
<i>Arnautoceclites mediterraneus</i> (Arthaber)	×	×	<i>Sibirites renzi</i> n. sp.		×
<i>Prosphingites ali</i> Arthaber		×	<i>Tirolites idrianus</i> (Haner)	×	
<i>Zenoites helenae</i> Renz and Renz		×	<i>Dinarites dalmatinus</i> (Haner)		×
<i>Zenoites vonderschmitti</i> (Renz and Renz)		×	<i>Dinarites liatsikasi</i> Renz and Renz		×
<i>Isclutitoides originis</i> (Arthaber)	×	×	<i>Hellenites praematurus</i> (Arthaber)	×	×
<i>Chiotites globularis</i> Renz and Renz		×	<i>Hellenites radiatus</i> Renz and Renz		×
<i>Tunglanites alexi</i> n. sp.	×	×	<i>Beyrichites laurac</i> Renz and Renz		×
<i>Subcolumbites perrinismithi</i> (Arthaber)	×	×	<i>Eogymnites arthaberi</i> (Diener)	×	
<i>Subcolumbites dussumi</i> (Arthaber)	×	×	<i>Eophyllites dieneri</i> (Arthaber)	×	×
<i>Vickohlerites sundaicus</i> (Welter)		×	<i>Palacophyllites steinmanni</i> Welter		×
<i>Prenkites malsorensis</i> (Arthaber)	×	×	<i>Leiophyllites variabilis</i> Spath	×	×

and varieties placed in 38 genera and subgenera; a list of these taxa is as follows:

Columbites europacus Arthaber
Columbites perrinismithi Arthaber
Columbites europacusperrinismithi Renz and Renz
Columbites mirditeusis Arthaber
Columbites diana Renz and Renz
Columbites diana var. Renz and Renz
Columbites parisianus Hyatt and Smith
Columbites spencei Smith var. *chiotica* Renz and Renz
Columbites ex aff. *plicatuli* Smith
Columbites malayanus C. Renz
Columbites malayanus var. C. Renz
Columbites malayanus C. Renz var. *crassa* Renz and Renz
Columbites bubulinae Renz and Renz
Columbites gracoamericanus Renz and Renz
Columbites levantinus Renz and Renz
Columbites aithaliae Renz and Renz
Columbites hellenicus Renz and Renz
Prenkites malsorensis Arthaber var. Renz and Renz
Prenkites sundaicus Welter
Prenkites helenae Renz and Renz
cf. *Styrites lilangensis* Diener

Isclutites originis Arthaber
Isclutites globulus Renz and Renz
Isclutites globulus var. Renz and Renz
Isclutites antiglobulus Renz and Renz
Isclutites antiglobulus var. Renz and Renz
Isclutites globulusoriginis Renz and Renz
Isclutites globulusantiglobulus Renz and Renz
Anasibirites aff. *anguloso* (Waagen)
Chioceras mizopouloi Renz and Renz
Chioceras mizopouloi var. *meridionalis* Renz and Renz
Chioceras nodosum Renz and Renz
Prosphingites ex aff. *czekanowskii* Mojsisovics
Prosphingites vonderschmitti Renz and Renz
Prosphingites (Chiotites) globularis Renz and Renz
Prosphingites (Chiotites) superglobosus Renz and Renz
Prosphingites (Zenoites) helenae Renz and Renz
Prosphingites (Zenoites) helenae var. *maradovensis* Renz and Renz
Celtites keirensis Arthaber
Epiceltites gentii Arthaber
Hellenites praematurus (Arthaber)
Hellenites praematurus var. *aegagica* Renz and Renz
Hellenites trikkaliuoi Renz and Renz

- Hellenites trikkalinoi* var. Renz and Renz
Hellenites trikkalinoi var. *gracca* Renz and Renz
Hellenites (*Pallasites*) *radiatus* Renz and Renz
Hellenites (*Pallasites*) *striatus* Renz and Renz
Hellenites (*Pallasites*) *striatus* var. *densicostata* Renz and Renz
Dinarites nudus Mojsisovics
Dinarites evolutior Kittl
Dinarites liatsikasi Renz and Renz
Stacheites dionysi Renz and Renz
Stacheites dionysi var. Renz and Renz
Dagnoceras terbunicum Arthaber
Dagnoceras nopsanum var. *involuta* Renz and Renz
Meekoceras cf. *gracilitatis* White
Inyoites garbinus Renz and Renz
Ophiceras cf. *demissum* Oppel
Flemingites pseudorusselli Renz and Renz
Lecanites skutarensis Arthaber
Lecanites discus Arthaber
Xenodiscus sulioticus Arthaber
Koninckites bernoulli Renz and Renz
Koninckites bernoulli var. Renz and Renz
Koninckites timorensis Renz and Renz
Beyrichites praematurus Renz and Renz
Beyrichites laurae Renz and Renz
Proptychites mohamedis (Arthaber) var. *applanata* Renz and Renz
Proptychites ktenasi Renz and Renz
Proptychites arthaberi Welter
Proptychites balcanicus Renz and Renz
Proptychites mistardisi Renz and Renz
Proptychites laurencianus (de Koninck) mut. *postindica* Renz and Renz
Proptychites buxtorfi Renz and Renz
cf. *Nannites hindostanus* Diener
cf. *Nannites medius* Krafft and Diener
Paranannites aspenensis Hyatt and Smith var. *europaea* Renz and Renz
Paranannites mediterraneus Arthaber
Paranannites mediterraneus var. *media* Renz and Renz
Paranannites chionensis Renz and Renz
Paranannites compressus Renz and Renz
Monophyllites (*Leiophyllites*) *praeconfucii* Renz and Renz
Monophyllites (*Leiophyllites*) *georgalasi* Renz and Renz
Monophyllites (*Leiophyllites*) *rosae* Renz and Renz
Monophyllites (*Leiophyllites*) *dieneri* Arthaber var. *involuta* Renz and Renz
Monophyllites (*Leiophyllites*) *palaeotriadicus* Renz and Renz
Monophyllites (*Leiophyllites*) aff. *pitamaha* Diener
Monophyllites (*Schizophyllites*) *betilloni* Renz and Renz
Monophyllites (*Schizophyllites*) *betilloni* var. *evoluta* Renz and Renz
Monophyllites (?*Schizophyllites*) *pseudohara* Renz and Renz
Monophyllites (*Palacophyllites*) *thalmanni* Renz and Renz
Monophyllites (*Palacophyllites*) *prackiepert* Renz and Renz
Procarnites kokeni Arthaber
Procarnites kokeni var. Renz and Renz
Procarnites kokeni var. *evoluta* Renz and Renz
Procarnites kokeni var. *panteleimonensis* Renz and Renz
Procarnites skanderbegis Arthaber
Hedenstroemia pityoussae Renz and Renz
Pronorites triadicus Arthaber var. Renz and Renz
Pronorites arbanus Arthaber
Pronorites arbanus Arthaber var. Renz and Renz
Pronorites arbanus Arthaber var. *mediterranea* Renz and Renz
Pronorites orientalis Renz and Renz
Pronorites cf. *osmanicus* Arthaber
Pronorites schaubi Renz and Renz
Pronorites schaubi var. *kephalovunensis* Renz and Renz
Pronorites reicheli Renz and Renz
cf. *Cordillerites angulatus* Hyatt and Smith
Pseudosagecceras cf. *clavisellatum* Diener
Pseudosagecceras intermontanum Hyatt and Smith
Pseudosagecceras drinense Arthaber
Pseudosagecceras drinense var. *incentrolata* Renz and Renz
Pseudosagecceras (*Metasagecceras*) *pasquayi* Renz and Renz
Sagecceras albanicum Arthaber var. Renz and Renz
Arianites (*Meropella*) *plejjanae* Renz and Renz
cf. *Paragoceras dukagini* Arthaber

My own study of the Renz collection in the Natural History Museum, Basel, leads me to conclude that the fauna consists of 41 species placed in 27 genera. A summary of my taxonomic conclusion is given on Table 18. The illustrations of this fauna in the Renz and Renz (1948) monograph are excellent and thus need not be reproduced here.

The *Subcolumbites* faunas of Chios and Albania contain a few specimens that are "normal" Anisian species. In the Chios fauna there is *Beyrichites laurae*, recognized on the basis of three specimens, and in the Albanian fauna there is *Eogymnites arthaberi*. The preservation in red limestone and the distribution of the fossils in lenticular "pockets," at least as far as the Chios fauna is concerned, does raise a question of possible mixing. Renz and Renz (1948:61)

recognized the unusual aspect of *Beyrichites* in their Chios fauna but came to the conclusion that the faunas were not mixed. The fact that *Beyrichites* is represented by only three specimens tends to support their thesis. On the basis of the data available I have elected to accept *Beyrichites* as a valid member of the late Scythian ammonoid faunas.

Werfen Formation

The ammonite fauna of the Werfen Formation of the Alps and associated regions, characterized by the great abundance of *Tirolites*, has been an enigma among Scythian faunas. It is a unique fauna quite unlike that of any other of the Scythian. This uniqueness is the cause of an array of conflicting opinions as to its age. A review of the conclusions on the age of this fauna by such pioneer students as Mojsisovics, Waagen, Diener, etc. cannot serve any useful purpose here. It was J. P. Smith (1932) who provided the basis for the prevalent current interpretation of the age relations of the *Tirolites* fauna. Within the Thaynes Formation cropping out in Paris Canyon, southeast Idaho, Smith encountered a poorly preserved fauna 225 feet above the *Meekoceras* fauna and 30 feet below his *Columbites* fauna. Within this fauna, Smith (1932:11) recognized four species of ammonites: *Dalmatites attenuatus*, *Tirolites harti*, *T. knighti*, and *T. peali*. On the age and correlation of this small fauna Smith (1932:10) concluded: "*Tirolites* constitutes the most abundant and characteristic element of the fauna, with species closely allied with those of the Campil beds of the Tyrol, giving a definite correlation and marking the first appearance of Mediterranean types in the American Lower Triassic." Smith thus recognized a *Tirolites* Zone stratigraphically between his *Meekoceras* Zone below and the *Columbites* Zone above. This scheme was also adopted by Spath (1934:27), and in the Treatise (Kummel in Arkell, et al., 1957). The age relations of the so-called

Tirolites fauna thus hinged on the stratigraphic position of a small lot of poorly preserved ammonites from a single locality and horizon in southeastern Idaho. Needless to say, this was a most unsatisfactory situation.

The discovery and study of a number of new upper Scythian faunas in the past couple of decades has contributed many new faunal and stratigraphic data that warrant a new evaluation of the Werfen fauna. The most comprehensive previous analysis of the Werfen fauna was that by Kittl (1903) who recognized 59 species, listed below.

Dinarites laevis Tommasi
Dinarites muchianus (Hauer)
Dinarites evolutior Kittl
Dinarites biangulatus Kittl
Dinarites nudus Kittl
Dinarites dalmatinus (Hauer)
Dinarites multicosatus Kittl
Dinarites tirolitoides Kittl
Dinarites ?angulatus Kittl
Dinarites (Hercegovites) mohamedanus Mojsisovics
Dinarites (Hercegovites) dioeletiani Kittl
Dinarites (Liccaites) circumplicatus Mojsisovics
Dinarites (Liccaites) connectens Mojsisovics
Dinarites (Liccaites) liccaus (Hauer)
Dinarites (Liccaites) progressus Kittl
Stacheites priouoides Kittl
Ceratites (Paraceratites) prior Kittl
Tirolites (Hololobus) monoptychus Kittl
Tirolites carniolicus Mojsisovics
Tirolites serratolobatus Kittl
Tirolites idrianus (Hauer)
Tirolites heterophanus Kittl
Tirolites mercurii Mojsisovics
Tirolites paucispinatus Kittl
Tirolites seminuodus Mojsisovics
Tirolites distans Kittl
Tirolites queuestedti Mojsisovics
Tirolites robustus Kittl
Tirolites dimidiatus Kittl
Tirolites stachei Kittl
Tirolites dinarus Mojsisovics
Tirolites hybridus Kittl
Tirolites angustus Kittl
Tirolites subillyricus Kittl
Tirolites illyricus Mojsisovics
Tirolites repulsus Kittl
Tirolites rotiformis Kittl
Tirolites rectangularis Mojsisovics
Tirolites undulatus Kittl
Tirolites angustilobatus Kittl
Tirolites cassianus (Quenstedt)
Tirolites spinosus Mojsisovics

Tirolites haueri Mojsisovics
Tirolites multispinatus Kittl
Tirolites percostatus Kittl
Tirolites turgidus Mojsisovics
Tirolites daricini Mojsisovics
Tirolites spinosior Kittl
Tirolites smiriagini (Auerbach)
Tirolites kernerii Kittl
Tirolites toulai Kittl
Tirolites (*Scilajites*) *cingulatus* Kittl
Tirolites (*Scilajites*) *tietzei* Kittl
Tirolites (*Bittnerites*) *malici* Kittl
Tirolites (*Bittnerites*) *bittneri* Kittl
Tirolites (*Bittnerites*) *?telleri* Kittl
Kymatites svilajanus Kittl
Meekoceras caprilense Mojsisovics
Dalmatites morlaccus Kittl

I have had the opportunity of examining the very large collections of Werfen ammonites that constituted the basis for Kittl's monograph. All of Kittl's taxa are treated in the systematic portion of this report. My own analysis of this fauna leads me to believe it consists of only 13 species included in 9 genera. A summary list of these species is as follows:

Dalmatites morlaccus Kittl
Stacheites prionoides Kittl
Dinarites dalmatinus (Hauer)
Dinarites carniolicus (Mojsisovics)
Diaplococeras liccanum (Hauer)
Diaplococeras connectens (Mojsisovics)
Pseudokymatites svilajanus (Kittl)
Pseudodinarites mohamedanus (Mojsisovics)
Bittnerites bittneri Kittl
Hololobus monoptychus (Kittl)
Tirolites idrianus (Hauer)
Tirolites cassianus (Queuedt)
Tirolites cingulatus Kittl

The species of *Tirolites* completely dominate the fauna, being represented by several hundred specimens. *Dinarites* is also represented by many specimens but still considerably less than specimens of *Tirolites*. The other species are represented by very few specimens. *Stacheites prionoides*, *Pseudokymatites svilajanus* Kittl, and *Hololobus monoptychus* are represented only by a single specimen each. *Diaplococeras liccanum* is represented by 2 specimens, *Bittnerites bittneri* by 5 specimens, *Pseudodinarites mohamedanus* by 6 specimens, *Dalmatites morlaccus* by 10 specimens, and *Diaplococeras connectens* by 11 specimens.

Species of *Tirolites* and *Dinarites* include approximately 95 percent of all the specimens in this collection.

Recently, Ganév (1966) has described a small fauna from the Campil beds of Bulgaria, recognizing the following species:

Lanceolites discoidalis Ganév
Balkanites tabulatus Ganév
Tirolites bispinatus Ganév
Dinarites muchianus (Hauer)
Dinarites progressus Kittl

Through the courtesy of Dr. Ganév, I have photographs and plaster casts of the specimens illustrated in his paper. This is the first record of *Lanceolites* outside of North America where the type species of the genus is a prominent member of the *Meekoceras* fauna. *Balkanites* is a new genus known only from Bulgaria. The specimens assigned to *Tirolites bispinatus* I believe to be *Tirolites cassianus*; those assigned to *Dinarites progressus* belong in *Diaplococeras connectens*; and those assigned to *Dinarites muchianus* belong in *Dinarites dalmatinus*. It appears from Ganév's (1966) paper that he had only 10 specimens in his fauna.

As stated above, the age assignment of the Werfen fauna arrived at by Smith rests almost entirely on the position of the *Tirolites* fauna in the Thaynes Formation exposed in Paris Canyon, southeast Idaho. An evaluation of all genera and species in the Werfen fauna suggests a quite different age assignment. The Werfen fauna includes only 11 genera of ammonoids, but 6 of these (*Diaplococeras*, *Hololobus*, *Bittnerites*, *Pseudodinarites*, *Balkanites*, and *Pseudokymatites*) are endemic to the Werfen Formation. The species of these endemic genera are represented by only 27 specimens. The morphological characteristics of these genera are not of any particular help in establishing an age for the fauna. *Dalmatites* is represented in the *Tirolites* fauna of southeast Idaho (*D. attenuatus*) and in the overlying *Columbites* fauna (*D. kittli* n. sp.). Smith (1932:81) described *Dalmatites richardsi* from the

Meekoceras fauna of southeast Idaho. These are the only species of this genus recorded to date. I agree with Spath (1951: 20) that *Dalmatites ropini* Diener (1907: 93, pl. 9, figs. 5, 6) of Anisian age is generically distinct from the Scythian species mentioned above. *Lanceolites* was previously known only from two species in the *Meekoceras* limestone of western United States. The genus *Stacheites* is now known from four additional localities. Astakhova (1960b) records *Stacheites prionoides* from the uppermost of her faunal horizons in the Scythian formations on the Mangyshlak Peninsula. In fact, she named her uppermost zone the *Stacheites* Zone but did not describe or illustrate her specimens. Kummel (1966) recorded a poorly preserved specimen as *Stacheites* sp. indet. from the uppermost fossiliferous horizon of the Scythian strata in the Surghar Range of West Pakistan in a rock unit also containing *Prohungerites* sp., *Procarnites kokeni*, *Dagnoceras* cf. *zappanense*. In the systematic portion of this report *Stacheites floweri* n. sp. is described from the Tobin Formation of Nevada where it is associated with *Subcolumbites*, *Hemilecanites*, *Isculitoides*, etc. An indeterminate species of *Stacheites* from the *Prohungerites* fauna of the upper Thaynes Formation of southeast Idaho is described in the systematic portion of this paper. These four additional records of *Stacheites* are clearly from horizons assignable to the late Scythian *Prohungerites* Zone.

Species of *Dinarites* are the second most abundant form represented in the Werfen fauna. Fortunately, species of this genus are now known from the *Subcolumbites* fauna of Chios and from the Scythian Formation of the Mangyshlak Peninsula. The Chios specimens that Renz and Renz (1948) assigned to *Dinarites nudus* Mojsisovics and *Dinarites evolutior* Kittl are here considered more properly assigned to *Dinarites dalmatinus*. A third dinaritid in the Chios fauna, *Dinarites liatsikasi* Renz and Renz, is unique because of its close

similarity to *Dinarites undatus* Astakhova from the Mangyshlak Peninsula. *Dinarites undatus* is recorded from the *Tirolites* Zone of Astakhova, lying above beds containing *Procarnites kokeni* and *Prohungerites carinatus* and beneath horizons containing species of *Albanites*, *Olenekites*, *Epiceltites*, etc.

Finally, there is the genus *Tirolites*, the dominant element in the Werfen fauna and the genus Smith (1932) relied upon, almost entirely, in correlation of his *Tirolites* Zone. In concluding that *Tirolites* had a very narrow stratigraphic range, Smith (1932) ignored the species that Krafft and Diener (1909) described from the *Hedenstroemia* fauna of the Himalayas (*T. injucundus*), the specimens described by Arthaber (1911) from the *Subcolumbites* fauna of Albania, or his own record (Smith, 1932) of a species of *Tirolites* from his *Columbites* fauna. In addition, Popov (1961) has described tirolitids from late Scythian strata in northern Siberia, and Silberling (in Hose and Repenning, 1959) records tirolitids from a late Scythian horizon in western Utah. The genus *Tirolites* is the dominant element only in the Werfen Formation fauna; in all other recorded occurrences the genus is represented by relatively few specimens. The age span of the genus now clearly encompasses all of the upper half of the Scythian.

In summary, the Werfen Formation fauna contains 11 genera, 6 of which are endemic. One genus (*Dalmatites*) is known from the *Meekoceras* and *Columbites* faunas, another (*Lanceolites*) is known from the *Meekoceras* fauna. Two genera (*Stacheites* and *Dinarites*) are known from outside of the Mediterranean region by species from late Scythian faunas of *Prohungerites* Zone age. It thus appears to be unsound to rely on *Tirolites* to establish the age of the Werfen fauna; for this, much greater reliance can be put on *Stacheites* and *Dinarites*. This leads to the conclusion that the Werfen fauna is of late Scythian, *Prohungerites* Zone age.

Mangyshlak Peninsula

The presence of Scythian formations on the Mangyshlak Peninsula has been known for the better part of this century. In spite of several investigations of these strata there prevails considerable controversy over the stratigraphy and correlation of most of the units. M. V. Bajarunas (1936) was the first to present a stratigraphic sequence with a list of the ammonites present, which unfortunately included many *nomina nuda*. According to Bajarunas, the lowest 15 m of the Triassic section consist of limestones and marls which contain *Doricranites bogdoanus* v. Buch, *D. rossicus* Mojsisovics, *D. acutus* Mojsisovics, and *Subdoricranites discoides* (*nomina nuda* for both genus and species). It is of interest to note Bajarunas's comment that this fauna was characterized by numerous individuals but few species. Above this lower fossiliferous unit are 100 m of unfossiliferous siliceous shales. These are followed by 200 m of marly shales with seams of marly limestone and calcareous marly concretions, rich in ammonites. This series of strata is divisible into four units; the lowest part, of 23 m, contains *Ophiceras* cf. *demissum*, *Xenodiscus* sp., *Pseudosagecceras multilobatum* Noetling, *Neotoceras mokrinskii* Bajarunas (both genus and species *nomina nuda*). The next 30 m are chiefly characterized by *Pseudosagecceras multilobatum* Noetling, *Procolumbites karatauciki* Bajarunas (both genus and species *nomina nuda*), *Procarnites andrusovi* Bajarunas (*nomina nuda*), *Thermalites* n. sp. and other species. The third division, of 80 m, contains *Columbites* cf. *parisianus* Hyatt and Smith, *C. asiaticus* Bajarunas (*nomina nuda*), *C. dolnapensis* Bajarunas (*nomina nuda*), *C. adai* Bajarunas (*nomina nuda*), *C. ligatiformis* Bajarunas (*nomina nuda*), *C. tururpensis* Bajarunas (*nomina nuda*), *C. gracilis* Bajarunas (*nomina nuda*), *Tirolites* n. sp. and others (unnamed). The uppermost division, of 65 m, is characterized by several forms of *Tirolites* and *Dinarites*.

On the basis of this faunal sequence,

Bajarunas (1936) came to the conclusion that since *Doricranites* lay below beds containing *Pseudosagecceras* and *Ophiceras*, the *Doricranites* strata must be correlative with the *Otoceras* beds of the Himalayas, that is, at the base of the Scythian. However, the lack of any detailed discussion of these faunas or any illustrations, plus the large number of *nomina nuda*, are severe handicaps in formulating any judgment on the basis of Bajarunas' conclusions.

Kiparisova (1947) briefly discussed the Mangyshlak section and described some of the ammonites, making specific note of the fact that detailed stratigraphic data were lacking for much of the material available to her. However, she did describe from the upper unit (the 80 m unit below the uppermost division of 65 m with *Tirolites* and *Dinarites*) of Bajarunas' section *Columbites dolnapaensis* Kiparisova (= *C. dolnapaensis* Bajarunas MS), *Kashmirites subdimorphus* Kiparisova, *Anasibirites gracilis* Kiparisova (= *Columbites gracilis* Bajarunas MS), and *Tirolites rossicus* Kiparisova.

In the volume on the stratigraphy of the USSR, Kiparisova (1958a) contributed some additional data on the Mangyshlak sequence and the faunal associations. She states that the sequence begins with up to 250 m of calcareous shales of which the lower 10 m consist of sandy shale and coarse sandstone with lenses of conglomerate. Above the lower sandy bed, the shales contain beds of limestone with abundant ammonoids (*Doricranites bogdoanus* v. Buch, *Tirolites cassianus* Quenstedt, *Procarnites andrusovi* Kiparisova, *Pseudosagecceras multilobatum* Noetling, etc.) and pelecypods. Above this are up to 400 m of argillaceous and sandy shales with interbedded limestone and sandstone. The limestones contain ammonoids (*Columbites* cf. *parisianus* Hyatt and Smith, *Tirolites cassianus* Quenstedt, *Procarnites andrusovi* Kiparisova, *Anasibirites gracilis* Kiparisova, and others) plus pelecypods, gastropods, and brachiopods. Kiparisova placed these horizons in the upper half of the Scythian.

TABLE 19. STRATIGRAPHY AND FAUNAS OF SCYTHIAN STRATA ON THE MANGYSHLAK PENINSULA AFTER ASTAKHOVA (1960 a, b; 1964). THE SPECIES MARKED WITH AN ASTERISK WERE ONLY LISTED BY ASTAKHOVA; THEY WERE NEITHER DESCRIBED NOR ILLUSTRATED.

TYUR-UPA SUITE (750-800m)	sandstone shale member	<i>Stacheites</i> Zone	<i>Leiophyllites radians</i> Astakhova
			<i>Nannites bajaranasi</i> Astakhova
	shale member	<i>Columbites</i> Zone	* <i>Paranannites aspenensis</i> Hyatt and Smith
			* <i>Stacheites prionoides</i> Kittl
			<i>Albanites danispanensis</i> Astakhova
			<i>Anasibirites subgracilis</i> Astakhova
			<i>Anasibirites gracilis</i> Kiparisova
			* <i>Olenckites tururpeusis</i> Astakhova
			<i>Olenckites mangyshlakensis</i> Astakhova
			<i>Procolumbites karataucikus</i> Astakhova
			<i>Columbites constrictilis</i> Astakhova
			* <i>Columbites parisianus</i> Hyatt and Smith
	limestone-shale member	<i>Tirolites</i> Zone	<i>Columbites doluapaensis</i> Kiparisova
			<i>Dinarites nudatus</i> Astakhova
			<i>Kashmirites subdimorphus</i> Kiparisova
			<i>Kashmirites contortus</i> Astakhova
			<i>Tirolites impolitus</i> Astakhova
			<i>Tirolites elegans</i> Astakhova
			* <i>Tirolites smiriagini</i> (Auerbach)
			* <i>Tirolites cassianus</i> (Quenstedt)
			* <i>Tirolites spinosus</i> Mojsisovics
			* <i>Tirolites rossicus</i> Kiparisova
		<i>Pseudosageceras</i> Zone	<i>Procarinites andrusovi</i> Kiparisova
			* <i>Pseudosageceras multilobatum</i> Noetting
		<i>Doricranites</i> Zone	<i>Doricranites tumulosus</i> Astakhova
			<i>Doricranites lauecolatus</i> Astakhova
			* <i>Doricranites rarecostatus</i> Astakhova
			* <i>Doricranites discus</i> Astakhova
			<i>Doricranites scharicus</i> Astakhova
			* <i>Doricranites ovatus</i> Astakhova
			<i>Doricranites rossicus</i> (Mojsisovics)
			<i>Doricranites bogdoanus</i> (v. Buch)
			<i>Doricranites acutus</i> (Mojsisovics)
			<i>Subdoricranites discoides</i> Astakhova
			<i>Subdoricranites orbiculatus</i> Astakhova
			<i>Kiparisovites carinatus</i> Astakhova

Related to Bajaranas' interpretation of the age of the *Doricranites* beds was the conclusion that the Permian-Triassic formations on the Mangyshlak Peninsula were gradational. In both these conclusions, Bajaranas received support from Shevyrev and Shlezinger (1960). These authors state that throughout the entire extent of the Kara-Tau Range there are no signs, even the most indirect, of an interruption in sedimentation or of a basal conglomerate. They likewise are emphatic that the lower

horizon with the *Doricranites* fauna does not contain *Tirolites*, as had been claimed by some authors. The short paper by Shevyrev and Shlezinger (1960) suffers from the same vague and incomplete data that characterized the contributions of Bajaranas (1936) and Kiparisova (1947, 1958a).

For the first comprehensive discussion of the stratigraphy and faunas of the Scythian formations on the Mangyshlak Peninsula we are indebted to Astakhova (1960a, b,

TABLE 20. SUMMARY LIST OF SPECIES RECOGNIZED IN THIS REPORT FROM EACH OF THE ZONES ESTABLISHED BY ASTAKHOVA (1960 a, b) IN THE SCYTHIAN OF THE MANGYSHLAK PENINSULA.

Stacheites Zone	<i>Leiophyllites radians</i> <i>Arnautoceltites bajarunasi</i>
Columbites Zone	<i>Albanites triadicus</i> <i>Epiceltites subgracilis</i> <i>Olenekites mangyshlakensis</i> <i>Procolumnites karataucikus</i> <i>Pseudoceltites dolnapaensis</i>
Tirolites Zone	<i>Dinarites undatus</i> <i>Eukashmirites</i> <i>subdimorphus</i> <i>Eukashmirites contortus</i> <i>Tirolites rossicus</i> <i>Tirolites impolitus</i>
Pseudosageceras Zone	<i>Procarmites kokeni</i>
Dorikranites Zone	<i>Prohungarites carinatus</i> <i>Dorikranites bogdoanus</i> <i>Dorikranites acutus</i>

1964). This author considered the Scythian strata, which she named the Tyur-Upa Suite, to be transgressive on the underlying Permian (Dolnapa Suite) formations. The basal 6–10 m of strata are stated to contain lenticular beds of conglomerate which include pebbles of the underlying red Permian Dolnapa Suite. Astakhova recognized a sequence of three lithologic members and five faunal zones within her Tyur-Upa Suite. These data are summarized on Table 19. The *Dorikranites* Zone was correlated with the “*Meekoceras*” beds of the Himalayas, the Primorye Region, and Timor. The *Pseudosageceras* Zone was correlated with the *Hedenstroemia* beds of the Himalayas, the *Flemingites* beds of Timor, the *Flemingites* beds of the Primorye Region, and the *Pseudosageceras* beds of the western United States. The *Tirolites* Zone was correlated with the *Tirolites* Zone of the eastern Alps and of southeast Idaho. The *Columbites* Zone was correlated with the *Subcolumbites* fauna of the Primorye Region, the *Olenekites* fauna of northern

Siberia, and the *Columbites* fauna of southeast Idaho. The *Stacheites* Zone was correlated with the *Prohungarites* Zone of Spath (1934).

Astakhova thus concluded that her Tyur-Upa Suite included all of the Scythian except for the lowest zone (*Otoceras*). Careful analysis of the described and illustrated species leads me to a quite different conclusion: that all of the Mangyshlak faunas belong to a single zone, that of *Prohungarites*. In the systematic portion of this paper each of the species from the Tyur-Upa Suite is discussed. A summary of the species that I recognize in each of Astakhova's zones is listed on Table 20.

Afghanistan

Excellent exposures of Lower Triassic Scythian strata occur at Kotal-e-Tera, 90 kilometers southeast of Kabul. A well preserved and diverse *Owenites* fauna has been described from this locality by Kummel and Erben (1968). A unique feature of this *Owenites* fauna is its complete mixing with a typical *Anasibirites* fauna. The beds containing the *Owenites* fauna are 75 feet thick and are overlain by 14 feet of strata that have yielded a poorly preserved *Subcolumbites* fauna. Kummel (1968) has recorded the following species from these beds:

Pseudosageceras multilobatum Noetling
Subvishnuites sp. indet.
Subvishnuites cf. *enveris* Arthaber
Xenoceltites sp. indet.
Procarmites kokeni (Arthaber)
Isculitoides cf. *originis* (Arthaber)
Subcolumbites perrinismithi (Arthaber)
Vickohlerites cf. *sundaicus* (Welter)
Meropella cf. *plejanae* Renz and Renz
Albanites triadicus (Arthaber)
Keyserlingites sp. indet.
Leiophyllites sp. indet.

These strata are overlain by black mudstones containing an Anisian fauna.

Salt Range, West Pakistan

The Ceratite beds of the Salt Range, West Pakistan, occupy an important place

in the development of Lower Triassic (Scythian) chronology. The geology of the Salt Range and Trans-Indus ranges was first monographed by Wynne (1878, 1880), and the ammonites monographed by Waagen (1895). In establishing a standard chronologic scheme for Triassic marine facies, Mojsisovics, Waagen, and Diener (1895) proposed the sequence of zones of the Salt Range as the type for the Lower Triassic. At that time the Ceratite beds were thought to comprise the entire Lower Triassic. It has long been recognized that, with a very few exceptions, the ammonoids from the Salt Range described by Waagen (1895) came from zones representing only parts of the middle and lower part of the Scythian.

A complete restudy of the Triassic formations in the Salt Range and Trans-Indus ranges has been published by Kummel (1966). The Ceratite beds of Wynne and Waagen have been named the Mianwali Formation, including three members: Kathwai, Mittiwali, and Narmia. Nearly all of Waagen's (1895) ammonoids came from the Mittiwali Member. The Narmia Member is approximately equivalent to the Dolomite group of Waagen (1895). From this stratigraphic horizon, Waagen (1895) described a single ammonoid specimen as *Pseudharpoceras spiniger*. Waagen considered this species to be closely related to the genus *Tropites* and concluded that it indicated a late Triassic (Keuper) age. It should be pointed out that *Pseudharpoceras spiniger* is based on a single specimen from an unknown horizon, but thought by Waagen to be from the topmost limestone unit of his Dolomite group in the Sheik-Budin Hills in the Trans-Indus Region. In addition, Waagen described *Dinarites sinuatus*, *Lecanites laqueus*, and *Lecanites planorbis* from his Bivalve beds, the basal unit of the Narmia Member.

Kummel's (1966) extensive field studies of the Triassic formation in the Salt Range and Trans-Indus ranges yielded a small,

and generally poorly preserved fauna including the following species:

Pseudosagecceras multilobatum Noetling
Subvishnuites sp. indet.
Xenoceltites sinuatus (Waagen)
Xenoceltites sp. indet.
Procarinites kokeni (Arthaber)
Isculitoides sp. indet.
Anakashmirites sp. indet.
Scalbardiceras sp. indet.
Stacheites sp. indet.
Dagnoceras sp. indet.
Nordophiceras planorbis (Waagen)
Nordophiceras cf. *planorbis* (Waagen)
Arctomeceoceras sp. indet.
Tirolites sp. indet.
Prohungarites cf. *crasseplicatus* (Welter)

India

Scythian strata have been recognized in the Himalayas for a century and have occupied an important role in the development of Scythian paleontology and stratigraphy. However, most of the abundant Scythian faunas known from Spiti to Kashmir belong to the lower half of that stage. The youngest Scythian horizon known is that of *Sibirites spiniger* from Byaus which is equivalent to the *Anasibirites* Subzone of the *Owenites* Zone, approximately mid-Scythian in age.

A late Scythian horizon is probably present in Kashmir as shown by the presence of *Prohungarites middlemissii* (Diener, 1913). This species is quite similar to *Prohungarites mckelvei* n. sp. from the upper Thaynes Formation of southeast Idaho. The genus *Prohungarites* is known from the Mangyshlak Peninsula, the Salt Range, Timor, Olenek region, Nevada, and southeast Idaho in horizons here considered late Scythian in age. The Kashmir species, however, was collected from loose blocks and no stratigraphic data are available.

Recently, Tozer (1965a) has suggested that the horizon of *Keyserlingites dieneri* in the Himalayas may be upper Scythian in age rather than lower Anisian, as concluded by Diener, Spath, and others. The age assignment of these beds has a sufficient number of ambiguities to warrant a thorough re-analysis.

Krafft and Hayden measured the following section near Lilang in Spiti (Diener, 1912:56):

- | | | |
|-----|---|--------|
| 4. | Dark grey limestone, often concretionary with shaly partings. Upper Muschelkalk | 22 ft. |
| 3f. | Grey limestone with <i>Ceratites ravana</i> | 16 in. |
| 3e. | Grey concretionary limestone | 6 in. |
| 3d. | Shales with <i>Spiriferina stracheyi</i> | 4 in. |
| 3c. | Grey limestone | 3 in. |
| 3b. | Hard, grey limestone with <i>Keyserlingites dieneri</i> | 4 in. |
| 3a. | Thin layers of grey limestone and shale | 3 ft. |
| 2. | Nodular limestone (Niti limestone of Noetling) | 60 ft. |
| 1. | Shaly limestone with <i>Rhynchonella griesbachi</i> | 3 ft. |

Krafft measured the following section in 1900 at the Bambanag Cliff (Diener, 1912:57):

- | | | |
|-----|---|---------|
| 4. | Upper Muschelkalk with numerous specimens of <i>Ptychites</i> , <i>Hollandites</i> , <i>Beyrichites khanikoffi</i> , <i>Gymnites vasantasena</i> | 20 ft. |
| 3i. | Shales with many concretions, containing <i>Spiriferina stracheyi</i> | 2 ft. |
| 3h. | Dark grey limestone with <i>Spiriferina stracheyi</i> and <i>Spirigera stoliczkai</i> | 1 ft. |
| 3g. | Black shales | 5 in. |
| 3f. | Dark grey limestone with <i>Keyserlingites dieneri</i> , <i>Monophyllites hara</i> , <i>M. kingi</i> , <i>Spiriferina stracheyi</i> , <i>Spirigera stoliczkai</i> | 5 in. |
| 3e. | Black shale | 2 in. |
| 3d. | Limestone as 3f containing <i>Gymnites</i> sp. | 7 in. |
| 3c. | Black shales | 5 in. |
| 3b. | Limestone as 3h with <i>Monophyllites</i> sp. and <i>Dalmanites ropini</i> | 6 in. |
| 3a. | Black shales with <i>Keyserlingites</i> sp. | 5-6 in. |
| 2. | Nodular limestone (Niti limestone of Noetling) unfossiliferous | 50 ft. |
| 1. | Earthy limestone with <i>Rhynchonella griesbachi</i> and <i>Retzia himalaica</i> | 3 ft. |

Thus the basic pattern of this stratigraphic interval is a thin limestone unit with *Rhynchonella griesbachi*, followed by a thick nodular, essentially unfossiliferous, limestone, then about six feet of limestone and shale, with *Keyserlingites dieneri*, etc., and at the top limestones with an abundant Anisian fauna. Diener (1912:55) emphasizes the homogeneity of this sequence of facies between Spiti and Painkhanda. In

regards to the cephalopod faunas of the Lower Muschelkalk, the sections at Spiti have yielded a considerably larger number of species than those of Painkhanda. A tabulation of the species Diener (1907) described from these Lower Muschelkalk sections is given on Table 21. There are only four species which are common to the two districts. For some reason, Tozer (1965a:11) based his argument mainly on the fauna from Bambanag Cliff; however, if we accept the correlation of strata as proposed by Diener, the large number of unquestionable Anisian species from the Spiti sections does not support a suggestion that these strata and faunas could be late Scythian in age. There is an additional bit of evidence that lends support to Diener's conclusions, and this is the fauna from the Middlemiss Crag near Chitichun. This is a fauna from "exotic" blocks that has six species in common with that of the Lower Muschelkalk of Spiti, and two species in common with the Lower Muschelkalk at Painkhanda (Table 21). The presence of such genera as *Psilosturia*, *Procladites*, etc., clearly indicates that this is Anisian in age; however, *Keyserlingites* is not present in this fauna.

Timor

Among the several beautifully preserved faunas of Scythian age from Timor, only one, that of "Block E bei Nifoekoko," is of late Scythian age. Welter (1922) described the following species from this fauna:

Columbites sp. ind.
Monophyllites sp. ind. ex aff. *dieneri* Arthaber
Palaeophyllites steinmanni Welter
Proptychites arthaberi Welter
Hungarites cf. *middlemissi* Diener
Hungarites crasseplicatus Welter
Hungarites tuberculatus Welter
Pronorites arbanus Arthaber
Pronorites sp. ind. ex aff. *arbanus* Arthaber

Welter (1922) noted that five of his nine species were related to species of the *Subcolumbites* fauna of Albania described by Arthaber (1908, 1911). He, however, placed the horizon of this fauna at about that of

TABLE 21. SUMMARY LIST OF SPECIES FROM THE LOWER MUSCHELKALK OF THE HIMALAYAS, TIBET AND TIMOR. DATA FROM DIENER (1895, 1907) AND WELTER (1915).

	Gyundi R., Spiti	Lilang, Spiti	Po, Spiti	Shalshal Cliff	Bam- banag Cliff	Middle- miss Crag	Timor (Welter Bed 2)	Timor (Welter Bed 3)
<i>Hollandites eyasa</i> Diener	×							
<i>Danubites kansa</i> Diener	×					×		
<i>Danubites ambika</i> Diener						×		
<i>Danubites alternecostatus</i> (Welter)							×	
<i>Danubites compressus</i> (Welter)							×	
<i>Keyserlingites dieneri</i> Mojsisovics		×		×	×			
<i>Keyserlingites pahari</i> Diener		×						
<i>Keyserlingites pagoda</i> Diener			×					
<i>Keyserlingites angustecostatus</i> Welter								×
<i>Japonites ugra</i> Diener		×				×	×	
<i>Japonites meridianus</i> Welter							×	
<i>Japonites raphaelis zojae</i> Tommasi							×	
<i>Stacheites webbianus</i> Diener		×						
<i>Dalmatites ropini</i> Diener		×			×			
<i>Sibirites prahlada</i> Diener		×						
<i>Sibirites pandya</i> Diener						×		
<i>Gymnites depauperatus</i> Diener		×						
<i>Gymnites volzi</i> Welter							×	
<i>Procladiscites yasoda</i> Diener						×	×	
<i>Psilosturia mongolica</i> (Diener)						×	×	
<i>Megaphyllites evolutus</i> Welter							×	
<i>Leiophyllites confucii</i> (Diener)		×				×		
<i>Leiophyllites pradyumna</i> (Diener)		×				×		
<i>Leiophyllites middlemissii</i> (Diener)						×		
<i>Leiophyllites pitamaha</i> (Diener)						×		
<i>Leiophyllites larvis</i> (Welter)							×	
<i>Leiophyllites indoaustratica</i> (Welter)							×	×
<i>Ussurites hara</i> (Diener)		×		×	×	×	×	×
<i>Ussurites kingi</i> (Diener)		×			×	×		
<i>Rommanites</i> cf. <i>simionescui</i> Kittl							×	

his *Owenites* limestone and approximately mid-Scythian in age.

The British Museum (Natural History) has large collections of Timor Scythian ammonoids. In the British Museum catalogue of Triassic ammonoids, Spath (1934) described a few new species from these blocks at Nifoekoko which are characterized by the manganese coating on the specimens. Kummel (1968) has likewise described new species from this fauna. In this report the species of ammonites recognized in the Nifoekoko fauna (with manganese coated specimens) are as follows:

- Proptychitoides arthaberi* (Welter)
- Procarnites kokeni* (Arthaber)
- Isculitoides originis* (Arthaber)
- Prenkites timorensis* Spath

- Dagnoceras zappanense* Arthaber
- Metadagnoceras freemani* Kummel
- Albanites triadicus* (Arthaber)
- Prohungarites crasseplicatus* (Welter)
- Prohungarites tuberculatus* (Welter)
- Eophyllites orientalis* Spath
- Palaeophyllites steinmanni* Welter

Included as a member of the *Prohungarites* Zone fauna of Timor is *Prenkites sundaicus* Welter. The one specimen on which this species is based came from Noel Niti, Timor, but no identifiable associated forms are known. This specimen has been selected as the type of a new genus, *Vickohlerites* Kummel (1968a).

Tozer (1965a:12) has suggested that the beds on Timor with *Keyserlingites angustecostatus* Welter are possibly late Scythian

in age. The fact that the Triassic of Timor is represented only by isolated blocks and that extremely condensed sections (within the blocks) are common has complicated interpretation of many of the Timor faunas. Most of the species that Welter (1915) assigned to the Anisian came from a single block of limestone within which three distinct layers were recognized. One of these layers, 60 cm thick, contained a typical Anisian fauna of 8 species, including *Acrochordiceras* (*Paracrochordiceras*) *anodosum* Welter, *Gymnites* sp., etc. Adjacent to this was a 30 cm thick unit with 14 species of ammonites which are listed in Table 21 (Welter's bed 2). Four of these species were first described from the Lower Muschelkalk of the Middlemiss Crag of Tibet, namely *Japonites ugra* Diener, *Procladiscites yasoda* Diener, *Psilosturia mongolica* (Diener), and *Ussurites hara* (Diener). Two of these species were first described by Diener from the Lower Muschelkalk at Lilang, Spiti (beds which contain *Keyserlingites dieneri*), namely *Japonites ugra* Diener and *Ussurites hara*. Tozer (1965a:12) agrees that this 30 cm unit is "undoubtedly Anisian" in age. Adjacent to this unit is a third, of 100 cm in thickness from which Welter recognized only three species, *Keyserlingites angustecostatus*, *Ussurites hara* (Diener) and *Leiophyllites indoaustralica* (Welter). It is this fauna that suggests to Tozer the possibility of an upper Scythian age on the basis that the two associated species "do not establish an Anisian age." However, *Ussurites hara* (Diener) and *Leiophyllites indoaustralica* occur also in Welter's unit 2 and *Ussurites hara* occurs in the Himalayas at Spiti, Paikhandu, and at the Middlemiss Crag, all units with an abundant Anisian fauna. Finally, among the specimens of *Keyserlingites angustecostatus* Welter in the British Museum, three fragments are from a "large block with *Gymnites* and *Leiophyllites*, etc., that also yielded *Parasageceras*" Spath (1934:359). The facts regarding these Timor faunas do not support the

suggestion that the 100 cm layer with *Keyserlingites angustecostatus* may be late Scythian in age.

New Zealand

Scythian ammonoids are extremely rare in New Zealand where only two small faunas have been discovered. The first of these faunas consisted of only 9 specimens placed in 4 species of *Owenites* Zone age (Kummel, 1959). The second fauna consisted of 24 specimens of a single species, *Prosphingites coombsi* Kummel (1965). The morphological characters of this species and its genetic relationships suggest that it is of late Scythian (*Prohungarites* Zone) age. *Prosphingites coombsi* is extremely close to *Prosphingites insularis* Kiparisova from the *Subcolumbites* fauna of the Primorye Region.

China

Our knowledge of the upper Scythian of China is derived mainly from a monograph by Chao (1959) on ammonite faunas from Kwangsi Province. Chao adopted the stratigraphic divisions of Spath (1934), and for the Columbitan division he recognized three zones:

Procarnites-Leiophyllites Zone
Columbitan division *Columbites costatus* Zone
Tirolites darwini Zone

An analysis of all of the taxa recognized by Chao in these upper Scythian zones is included in the taxonomic portion of this paper. The stratigraphic data are somewhat ambiguous but do not tend to support Chao's interpretation.

The *Tirolites* Zone was recognized on the basis of a single, poorly preserved fragment of body chamber collected from an isolated horizon 3 km southwest of Pachuan in the Fengshan district, Kwangsi. The identification of this ammonoid fragment is highly dubious. This, coupled with the complete lack of any associated fauna or stratigraphic data, leads me to reject this as a valid record of the so-called *Tirolites* Zone.

The remaining portion of Chao's Columbitan fauna is represented in three sections in western Kwangsi—the Naliling, the Yali, and the Chashanao.

The Naliling section is developed about one kilometer northeast of Lolou village and was divided by Chao (1959:158) into three divisions. The lower unit is composed of 15 m of black, thin bedded limestone. The middle unit is composed of grey, thin bedded limestone and calcareous shales, about 40 m thick. The upper unit consists of black, well bedded limestone 15–20 m thick, but the upper part of this unit is cut off by a fault. The lower unit contains an *Owenites* fauna. From the calcareous shale beds of the middle unit, Chao (1959) identified the following species (collections 541a, b of Chao):

Prosphingites lolouensis Chao
Meekoceras sp. indet.
Columbites asymmetricus Chao
Columbites ? sp.
Isculitoides sp.
Digitophyllites lolouensis Chao
Anakashmirites ? sp.

From the upper unit, below the fault, Chao (1959) recognized the following species (collections 542a of Chao):

Paranannites subglobosus Chao
Prosphingites involutus Chao
Columbites asymmetricus Chao
Preukites kwangsiensis Chao
Dagnoceras ellipticum Chao
Hellenites praematurus (Arthaber)
Celtites sp.

Within the village of Lolou, Chao (1959) uncovered an isolated limestone block from which he identified the following species of ammonites (collection 542b of Chao):

Procarinites oxynostus Chao
Procarinites acutus Spath
Cordillerites orientalis Chao
Proptychitoides compressus Chao
Tunglanites lenticularis Chao
Paranannites subglobosus Chao
Isculitoides ellipticus Chao
Isculitoides aff. *originis* (Arthaber)
Xenoceltites crenocentrosus Chao
Xenoceltites compressus Chao

Leiophyllites oxynostus Chao¹
Leiophyllites lolouensis Chao¹
Leiophyllites serpentinus Chao
Digitophyllites lolouensis Chao
Submeekoceras compressum Chao
Submeekoceras lolouense Chao
Submeekoceras longiseptatum Chao
Parussuria latilobata Chao
Anakashmirites aff. *nivalis* Diener
Lecanites sp.

The Yali section, in the Fengshan district, is stated by Chao (1959:173) not to have been well studied. It apparently represents a collection of ammonites (horizon 546 of Chao) from an unmeasured section. Chao identified the following ammonites from this section:

Proptychitoides ? *simplex* Chao
Columbites yaliensis Chao
Columbites huangi Chao
Columbites costatus Chao
Paranannites involutus Chao
Paranannites minutus Chao
Preukites kwangsiensis Chao
Fengshanites robustus Chao
Dagnoceras latilobatum Chao
Hellenites praematurus (Arthaber)

The Chashanao section lies on the border of the Hochih and Tunglan districts. The Scythian strata here consist of only 17 m of strata resting unconformably on Lower Permian limestones. Near the top of this sequence a 0.6 m bed of black limestone yielded the following ammonites, identified by Chao (1959, his horizon 610):

Subcolumbites kwangsiensis Chao
Columbites huangi Chao
Isculitoides globosus Chao
Tunglanites lenticularis Chao
Paradiarites suni Chao
Anakashmirites sp.
Proptychitoides tunglanensis Chao
Hemilecanites discus Arthaber

Chao concludes that the fauna of his collections 541a, b, 546, and 610 is es-

¹ In the list of species from this collection Chao (1959:160) does not include these two species. Instead, he has *Leiophyllites kwangsiensis* Chao sp. nov. and *L. verniformis* Chao sp. nov.; however, neither of these species is described in the taxonomic portion of his monograph. The two species listed above are from collection 542b.

TABLE 22. SUMMARY LIST OF SPECIES RECOGNIZED IN THIS REPORT FROM THE LATE SCYTHIAN OF KWANGSI, CHINA, IN TERMS OF THE FIVE DISTINCT COLLECTIONS STUDIED BY CHAO (1959).

	Nailing Section Collection 541 a, b	Nailing Section Collection 542 a	Ls. Block, Lolou Village Col. 542 b	Yali Section Collection 546	Chashanuo Section Collection 610
<i>Cordillerites angulatus</i>			×		
<i>Xenoceltites crenoventrosus</i>			×		
<i>Hemilecanites discus</i>					×
<i>Proptychitoides tunglanensis</i>			×	×	×
<i>Procarmites kokeni</i>			×		
<i>Procarmites lolouensis</i>	×		×		
<i>Arnauceltites involutus</i>				×	
<i>Prospiringites lolouensis</i>	×				×
<i>Prospiringites subglobosus</i>		×	×		
<i>Isculitoides ellipticus</i>			×		
<i>Tunglanites lenticularis</i>			×		×
<i>Subcolumbites perrinismithi</i>	×	×			×
<i>Subcolumbites robustus</i>				×	
<i>Paradinarites suni</i>					×
<i>Prenkites timorensis</i>		×		×	×
<i>Parussuria latilobata</i>			×		
<i>Dagnoceras ellipticum</i>		×			
<i>Dagnoceras latilobatum</i>				×	
<i>Nordophiceras compressum</i>			×		
<i>Hellenites praematurus</i>		×		×	
<i>Leiophyllites serpentinus</i>			×		

sentially the same and comprises his Zone of *Columbites costatus*. Because a specimen identified as *Procarmites kokeni* was found from the top part of the Lower Triassic limestone sequence east of Lolou, Chao (1959:160) concludes that his collection 542b (the loose block) "may represent the highest horizon of the *Columbites* stage" and refers this fauna to his *Procarmites-Leiophyllites* Zone.

All of the taxa described by Chao from these sections are discussed in the taxonomic portion of this paper. This study leads me to conclude that there are only 21 species of ammonites in these four collections. These are listed on Table 22 along with their geographic occurrence. The limestone block, collection 542b, which Chao assigned to his *Procarmites-Leiophyll-*

ites Zone, comprises 11 species. Four of these species occur in one or more of the remaining three collections. Of the seven remaining species, *Cordillerites angulatus* ranges throughout the upper half of the Scythian; the genus *Xenoceltites* ranges throughout the upper half of the Scythian and is not common in late Scythian formations; *Procarmites kokeni* is a common element of the *Subcolumbites* fauna of Albania and Chios, and it is also known from the Salt Range and from the *Prohungarites* fauna of Timor; the genus *Isculitoides* is apparently confined to the late Scythian and occurs in most localities where such faunas are known; *Parussuria latilobata* is the only species of this genus from a late Scythian horizon; *Nordophiceras* is known from the *Olenekites* fauna and *Dieneroceras* fauna of northern Siberia, the *Columbites* fauna of southeastern Idaho, and from the Salt Range of West Pakistan; forms like *Leiophyllites serpentinus* are common in the *Subcolumbites* fauna of Albania, Chios, and the Primorye Region.

I can see no actual difference in the faunal composition of collection 542b and collections 610, 542a, and 541a, b. Taking into account the factors of preservation, collection failure, and the composition of other late Scythian faunas, as those at Albania, Chios, Timor, Primorye, etc., plus the fact that there are no stratigraphic data on collection 542b, these four collections appear more likely to represent one single zone.

Japan

The present data on Triassic stratigraphy and ammonite faunas of Japan have been very ably summarized by Bando (1964a, 1966). The upper Scythian is represented by two specimens of *Subcolumbites perrinismithi* from the Osawa Formation in the Kitakami Massif.

Primorye Region

This is another of the classic areas that have occupied an important place in Scyth-

ian studies going back to 1895 when Diener published the first monograph on ammonites from this region. There have been a number of studies on the ammonites and pelecypods of these faunas; however, it is largely through the writings of Kiparisova (1947, 1961) that a picture of the stratigraphy and paleontology can be assessed. Korzh (1957, 1959) has contributed to our understanding of the petrography and paleogeography of the Primorye Scythian formations. Regional stratigraphic data as yet leave much to be desired. The Scythian formations of the Primorye Region represent 350–700 m of strata (Kiparisova, 1961: 191). Four assemblages of ammonites are recognized within these formations. Kiparisova (1961) named the lowest assemblage the *Proptychites* Zone, which she correlated with the Otoceratan and Gyronitan ages of Spath (1934). This assemblage is confined to 100–200 m of strata. In the overlying 50 m of strata a *Flemingites* Zone was recognized and correlated with the Flemingitan age of Spath (1934). The third faunal assemblage Kiparisova (1961) named the *Prosphingites* Zone. This assemblage is clearly identical to the *Meekoceras* fauna of the western United States. Recently, Kiparisova and Popov (1964) have presented evidence to the effect that the *Flemingites* Zone and *Prosphingites* Zone of the Primorye Region are equivalent, and they recommend excluding the *Flemingites* Zone from the Scythian time scale.

The fourth and uppermost faunal assemblage in the Primorye Scythian formations was named the *Subcolumbites* Zone by Kiparisova. This upper zone encompasses 100–150 m of strata. It is the fauna of this zone that is pertinent to this paper. Kiparisova (1961) recognized the following species from her *Subcolumbites* Zone:

Pseudosageceras simplex Kiparisova
Pseudosageceras longilobatum Kiparisova
Dieneroceras dieneri (Hyatt and Smith)
Xenocellites spitsbergensis Spath
Prosphingites globosus Kiparisova
Prosphingites insularis Kiparisova
Subcolumbites multiformis Kiparisova

Subcolumbites solitus Kiparisova
Subcolumbites anomalus Kiparisova
Parauannites gracilis Kiparisova
Parauannites suboviformis Kiparisova
Paranannites minor Kiparisova
Leiophyllites praematurus Kiparisova
Eophyllites amurensis Kiparisova
Danubites (*Danubites*) *adularis* Kiparisova
Danubites (*Danubites*) *incertus* Kiparisova
Danubites (*Preflorianites*) *inflatus* Kiparisova
Danubites (*Preflorianites*) *maritimus* Kiparisova
Megaphyllites immaturus Kiparisova

The above species are apparently in direct association with *Subcolumbites*. In addition, there are four species from the upper Scythian formations of the Primorye Region whose relations with the *Subcolumbites* assemblage are not clear. First, there is *Hellenites* (?) *inopinatus* Kiparisova which occurs at Cape Zhitkov, a locality with a well developed *Subcolumbites* fauna. Next, there is *Prohungarites* (?) *popovi* Kiparisova from the strata on the west coast of Amur Bay which Kiparisova considers to be latest Scythian or earliest Anisian in age. Finally, there are two species—*Columbites* sp. indet. and *Dagnoceras* ? *unicum* Kiparisova—that Kiparisova lists separately as beneath the main *Subcolumbites* fauna.

Recent studies by Zakharov have greatly increased our knowledge of the stratigraphy and paleontology of the Primorye Scythian deposits. Zakharov (1966; additional personal communication, 1967) recognizes a single Scythian zone above that of *Owenites koeneni* to which he gives the name *Columbites parisianus* Zone. Within this zone he recognizes two subzones, a lower *Neocolumbites insignis* Subzone and an upper *Subcolumbites multiformis* Subzone. Zakharov's zonal scheme with the key species for each segment is as follows:

	<i>Prosphingites insularis</i> Kiparisova,
<i>Subcolumbites</i>	<i>P. globosus</i> Kiparisova, <i>Subcolumbites multiformis</i> Kiparisova,
<i>multi-</i>	<i>Prenkites</i> aff. <i>timorensis</i> Spath,
<i>formis</i>	<i>Paranannites gracilis</i> Kiparisova,
	<i>Megaphyllites immaturus</i> Kiparisova.
<i>Columbites parisianus</i>	<i>Scalbardiceras parisense</i> Zakharov, <i>Metadagnoceras unicum</i>

Neocolumbites (Kiparisova), *Columbites parisianus* Hyatt and Smith, *Proinsignis columbites* sp., *Neocolumbites insignis* Zakharov, *Keyserlingites meridianus* Zakharov, *Olenekites sonticus* Zakharov, *Hellenites inopinatus* Kiparisova, *H. tchernyschewiensis* Zakharov.

Zakharov's complete monograph on the Scythian faunas of the Primorye Region is not available to me at this moment. On the basis of the data available, the ammonoids of the *Subcolumbites* fauna of the Primorye Region include the following species:

Pseudosageceras multilobatum Noetling
Pseudosageceras simplex Kiparisova
Dieneroceras karazini n. sp.
Xenoceltites spitsbergensis Spath
Procarinites immaturus (Kiparisova)
Arnautoceltites gracilis (Kiparisova)
Prosphingites globosus Kiparisova
Prosphingites insularis Kiparisova
Isculitoides suboviformis Kiparisova
Subcolumbites multiformis Kiparisova
Preukites aff. *timorensis* Spath
Leiophyllites admaris (Kiparisova)
Leiophyllites maritimus (Kiparisova)
Leiophyllites variabilis (Spath)

As mentioned above, Kiparisova (1961) was uncertain as to the precise horizon of *Prohungarites* (?) *popovi* Kiparisova. Zakharov (personal communication) informs me that he has found *Arctohungarites primoriensis* Zakharov, *Megaphyllites atlasoviensis* Zakharov, and *Leiophyllites praematurus* Kiparisova on the west coast of Amur Bay at a horizon 30 m below beds with *Prohungarites* (?) *popovi*, and concludes that it is an Anisian form. In this I agree.

One of the more important contributions that Zakharov has made toward our understanding of the Scythian of the Primorye Region is the recognition of the *Columbites* Zone which he assigned to his *Neocolumbites insignis* Subzone. In the monograph by Kiparisova (1961), it could only be inferred, primarily on the basis of stratigraphic position, that *Columbites* sp. indet. and *Dagnoceras unicum* most probably represented the *Columbites* Zone. Zakharov (personal communication) lists the fol-

lowing species from his *Neocolumbites insignis* Subzone:

Svalbardiceras parisense Zakharov
Metadagnoceras unicum (Kiparisova)
Columbites parisianus Hyatt and Smith
Procolumbites sp.
Neocolumbites insignis Zakharov
Keyserlingites meridianus Zakharov
Olenekites sonticus Zakharov
Hellenites inopinatus Kiparisova
Hellenites tchernyschewiensis Zakharov

Columbites parisianus is the name giver and primary member of the *Columbites* fauna of southeastern Idaho. In addition, the Idaho fauna also includes species of *Svalbardiceras*, *Keyserlingites*, and *Hellenites*. The relationship of the Primorye *Columbites* fauna with that of the *Dieneroceras* Zone of northern Siberia, which I consider equivalent to the *Columbites* fauna of southeast Idaho, is less direct; there is not a single genus or species in common. However, there is a close tie between the fauna of the *Dieneroceras* Zone of northern Siberia and the *Columbites* fauna of Idaho, especially in species of *Dieneroceras*, *Pseudaspidites*, and *Nordophiceras*.

Northeastern Siberia

Until a decade ago our knowledge of the Lower Triassic of northeastern Siberia rested almost entirely on two contributions of Mojsisovics (1886, 1888). In recent years our knowledge of this region has greatly increased, largely due to the writings of Yu. N. Popov. A summary of the stratigraphy of the major outcrop areas in this area of Siberia can be found in Popov (1958, 1960). Data on the sedimentology and paleogeography of the Permian and Lower Triassic formations in the Verkhoyansk Range can be found in Shutov (1958). The principal recent discussion of the ammonites of this region is in a monograph by Popov (1961).

In the general area of the Olenek River region, the Scythian comprises two facies and stratigraphic units. The lower unit is a clastic facies with *Estheria* and plant re-

mains; this is overlain by a marine elastic unit containing two ammonoid faunas—the *Dieneroceras* fauna of Popov, overlain by the *Olenekites* fauna. Further to the east, lower Scythian ammonoid horizons occur, but these are not the concern of this report.

The age and correlation of the *Olenekites* fauna have been under discussion ever since its monographic treatment by Mojsisovics (1886, 1888). This author recognized the following species in this fauna:

Dinarites spiniplicatus Mojsisovics
Dinarites volutus Mojsisovics
Dinarites densiplicatus Mojsisovics
Dinarites altus Mojsisovics
Dinarites intermedius Mojsisovics
Dinarites glacialis Mojsisovics
Dinarites laevis Mojsisovics
Dinarites tolli Mojsisovics
Ceratites signatoides Mojsisovics
Ceratites multiplicatus Mojsisovics
Ceratites hyperboreus Mojsisovics
Ceratites fissiplicatus Mojsisovics
Ceratites discretus Mojsisovics
Ceratites middendorffi Keyserling
Ceratites schrencki Mojsisovics
Ceratites subrobustus Mojsisovics
Ceratites nikitini Mojsisovics
Ceratites hangei Mojsisovics
Ceratites decipiens Mojsisovics
Ceratites inostranzeffi Mojsisovics
Sibirites eichwaldi (Keyserling)
Sibirites pretiosus Mojsisovics
Xenodiscus cuomphalus (Keyserling)
Xenodiscus schmidtii Mojsisovics
Xenodiscus dentosus Mojsisovics
Meekoceras karpinskii Mojsisovics
Meekoceras rotundatum Mojsisovics
Meekoceras sibiricum Mojsisovics
Prospiringites czekanowskii Mojsisovics

In his recent monographic treatment of the Olenek fauna, Popov (1961 and 1962a) recognized the following species:

Pseudosageceras longilobatum Kiparisova
Columbites (?) aff. *ornatus* Smith
Columbites morpheos Popov
Tirolites ex gr. *cassianus* (Quenstedt)
Tirolites gerbacensis Popov
Sibirites eichwaldi (Keyserling)
Sibirites pretiosus Mojsisovics
Sibirites subpretiosus Popov
Parasibirites granbergi (Popov)
Parasibirites rariaculatus Popov
Parasibirites mixtus Popov
Olenekites spiniplicatus Mojsisovics
Olenekites glacialis Mojsisovics

Olenekites altus Mojsisovics
Nordophiceras schmidtii (Mojsisovics)
Boreomeekoceras keyserlingi (Mojsisovics)
Keyserlingites middendorffi (Keyserling)
Keyserlingites subrobustus (Mojsisovics)
Keyserlingites nikitini (Mojsisovics)
Prospiringites czekanowskii Mojsisovics
Arctoceras simplex (Mojsisovics)
Procarinites kummeli Popov
Hemiprionites sibiricus (Mojsisovics)
Arctomeekoceras rotundatum (Mojsisovics)
Anasibirites rariocostatus Popov
Pseudotirolites menensis Popov

My own analysis of this fauna leads me to believe it consists of the following species:

Pseudosageceras multilobatum Noetling
Preflorianites multiplicatus (Mojsisovics)
Proptychitoides kummeli (Popov)
Prospiringites czekanowskii Mojsisovics
Czekanowskites decipiens (Mojsisovics)
Svalbardiceras schmidtii (Mojsisovics)
Svalbardiceras dentosus (Mojsisovics)
Svalbardiceras sibiricum (Mojsisovics)
Nordophiceras pseudosimplex n. sp.
Arctomeekoceras rotundatum (Mojsisovics)
Boreomeekoceras keyserlingi (Mojsisovics)
Sibirites pretiosus (Mojsisovics)
Keyserlingites middendorffi (Keyserling)
Keyserlingites subrobustus (Mojsisovics)
Olenekites spiniplicatus (Mojsisovics)
Tirolites morpheos (Popov)
Arctotirolites menensis Popov

Smith (1932) considered the *Olenekites* fauna as correlative with the *Columbites* fauna of southeast Idaho and the youngest zone of the Lower Triassic. Spath (1934) expressed considerable concern over correlation of the Olenek fauna, clearly recognizing the problem as it then existed. He concluded, however, that the Olenek fauna was latest Scythian in age and even suggested that his latest division of the Scythian could just as well be named Olenekitan. The time relationship of the *Olenekites* fauna and the *Prohungarites* fauna was clarified by the discovery of elements of these faunas associated together at a horizon approximately 1000 feet above the *Columbites* fauna in southeastern Idaho (Kummel, 1954). Popov (1961) concluded that the *Olenekites* Zone was correlative with the *Columbites* Zone. Kiparisova and Popov (1956) had previously arrived at a

similar conclusion. At a later date, Kiparisova and Popov (1961) accepted the *Prohungarites* Zone as being younger than the *Columbites* Zone and correlated the *Olenekites* fauna with it.

In a recent contribution, Kiparisova and Popov (1964) correlated the *Olenekites* fauna with the *Columbites* and *Tirolites* faunas of southeast Idaho, and recorded an additional younger zone, that of *Prohungarites tuberculatus* Welter. Descriptions of the fossils and stratigraphic sequence of this new assemblage are apparently in press. It is reasonable to expect that in this northern Siberian region two local zones could be useful for detailed stratigraphic analysis. On the other hand, on the basis of the data available, it appears more plausible that these two local zones are correlative with the *Prohungarites* Zone as interpreted here. The correlation of the *Olenekites* fauna with the *Columbites* fauna of southeast Idaho has no basis whatsoever.

This brings us to the problem of correlation of the *Dieneroceras* Zone of Popov. That author (Popov, 1961, 1962a) recognized the following species in this zone:

Pseudosageceras longilobatum Kiparisova
Dieneroceras demokidovi Popov
Dieneroceras apostolicus (Smith)
Dieneroceras khelaliensis Popov
Dieneroceras nikabitenis Popov
Nordophiceras karpinskii (Mojsisovics)
Nordophiceras alexeevae Popov
Nordophiceras olenekensis Popov
Nordophiceras contrarius Popov
Koninckites posterius Popov
Imyoites eickitensis Popov
Hemiprionites costatus Popov

My own analysis of this fauna leads me to believe it contains the following species:

Pseudosageceras multilobatum Noetling
Dieneroceras demokidovi Popov
Dieneroceras apostolicus (Smith)
Subvishnuites eickitensis (Popov)
Pseudaspidites posterius (Popov)
Nordophiceras enomphalus (Keyserling)
Nordophiceras alexeevae Popov
Hemiprionites costatus Popov

Popov (1962a) concluded that the fauna

of his *Dieneroceras* Zone was correlative with the *Owenites* Zone of the circum-Pacific region. In a personal communication, he further stated that he believed his fauna to be correlative to the *Anasibirites* Zone (upper *Owenites*). This correlation was followed by Kiparisova and Popov (1964). The conclusion arrived at here that the *Dieneroceras* Zone fauna of Popov is of *Columbites* Zone age is based primarily on the close relations and possible identity of the species of *Dieneroceras*, *Subvishnuites*, *Pseudaspidites*, and *Nordophiceras* with the forms in the *Columbites* fauna of southeast Idaho.

Spitsbergen

There is a considerable literature on Triassic stratigraphy and ammonoids of Spitsbergen. An extensive review of the older literature of the Triassic stratigraphy and paleontology with much new data has recently been published by Buchan, et al. (1965). The late Scythian is represented by only three species of ammonoids: *Keyserlingites subrobustus* and *Svalbardiceras spitzbergensis* Frebold, and *Svalbardiceras schmidtii* (Mojsisovics). These are typical representatives of the late Scythian (*Prohungarites* Zone) fauna of the circum-Arctic region.

Ellesmere Island

A number of localities in the Blaa Mountain and Blind Ford formations of Ellesmere Island have yielded a small but highly interesting late Scythian fauna. Tozer (1961a, 1965a) has recognized the following species in these faunas:

Olenekites canadensis Tozer
Svalbardiceras freboldi Tozer
Keyserlingites subrobustus (Mojsisovics)
Popovites borealis Tozer
Zenoites arcticus Tozer

The above assemblage of species includes several very typical late Scythian forms of the circum-Arctic region. Underlying the horizon which yields the above fauna, Tozer (1965a) records *Nordophiceras pilatum* (Hyatt and Smith) "associated with small

ammonoids, probably *Columbites* sp." This appears to identify the presence of the *Columbites* Zone.

British Columbia

Late Scythian ammonoids are apparently rare in British Columbia. Recently Tozer (1965a) has described a small fauna from three localities in northeastern British Columbia in the "Toad-Grayling Formation." All the specimens come from a 20-30 foot bed within the formation. From these three localities Tozer (1965a) has recognized the following species:

Procamrites modestus Tozer
Keyserlingites subrobustus (Mojsisovics)
Popovites occidentalis Tozer
Pseudosageceras bicarinatum Tozer
Leiohyphlites sp. indet.
Prospiringites cf. *P. czechanovskii* Mojsisovics
Preflorianites intermedius Tozer
Monacanthites monoceras Tozer
Metadagnoceras pulcher Tozer
Scalbardiceras chowadei Tozer
Isculitoides minor Tozer

My own analysis of this small fauna, consisting of 41 specimens, leads me to conclude that *Procamrites modestus* is a synonym of *Procamrites immaturus* (Kiparissova) from the Primorye Region and that *Pseudosageceras bicarinatum* is a synonym of *Cordillerites angulatus* Hyatt and Smith.

Tobin Formation, Nevada

The geology of the Tobin Formation, as it is developed in the Mount Tobin quadrangle, Nevada, has been ably discussed by Muller, et al. (1951). These authors recognized the Scythian age of the formation and recorded the following fossils from it: *Claraia* cf. *C. aurita*, *Myopharia* sp., *Lingula* sp., *Subcolumbites* sp., *Hungarites* sp. In addition, Muller has shown the author specimens of *Olenekites* from the Tobin Formation; the precise locality and horizon within the formation of these *Olenekites* is not known to the writer.

In 1959, in company with N.J. Silberling, then of the U.S. Geological Survey, we discovered a fossiliferous bed with well

preserved specimens a few tens of feet above the base of the Tobin Formation. This site has become USGS Mesozoic locality M2562 and is described geographically as follows (Silberling, written communication): "Pershing County, Nevada. South tip of Tobin Range, Cain Mountain 1:62,500 quad. Center NW ¼ Sec. 9, T. 26 N., R. 39 E. 5,500 feet south, 27.5 west from elevation point 5088 on range crest." The fauna we collected from this site yielded the following species:

Subcolumbites americanus n. sp.
Amantoceltites teichertii n. sp.
Stacheites floweri n. sp.
Isculitoides wasserbergi n. sp.
Ussurites sieveri n. sp.
Metadagnoceras tobini n. sp.
Hemilecanites paradiscus n. sp.

In the general vicinity of USGS locality M2562 talus blocks of unknown stratigraphic position within the Tobin Formation have yielded the following species:

Pseudosageceras multilobatum Noetling
Keyserlingites sp. indet.
Hellenites radiatus Renz and Renz
Prohungarites mckelvei n. sp.
Prohungarites sp. indet.

Confusion Range, Utah

The Thaynes Formation, including a series of fossiliferous horizons, is well developed in the Confusion Range of west-central Utah (Hose and Repenning, 1959). The lower beds of the Thaynes Formation, containing an abundant *Meekoceras* fauna, rest on the Gerster Limestone of Permian age; there is thus a significant hiatus between these formations. A second horizon with ammonoids occurs from 1,100 to 1,120 feet above the base of the Thaynes Formation. N. J. Silberling (in Hose and Repenning, 1959:2188) has identified "*Ophiceras*"? *spencei* Hyatt and Smith and "*Ophiceras*"? *jacksoni* Hyatt and Smith from this fauna. These are species occurring in the *Columbites* fauna of southeast Idaho and a correlation with that fauna is suggested. Abundant ammonites, of poor to fair preservation, were found from 1,420 to 1,530

feet above the base of the Thaynes (USGS Collection M111). Silberling (*in* Hose and Repenning, 1959:2188) identified in this collection *Proptychitoides mahomedis* (Arthaber), *Xenoceltites* cf. *X. spitsbergensis* Spath, *Tirolites* cf. *T. spinosus* Mojsisovics, *T. aff. haueri* Mojsisovics, and *Pseudosageceras* sp. Through the courtesy of Dr. N. J. Silberling I have had the opportunity of studying USGS collection M111 and have identified the following species:

Ussurites hoesi n. sp.
Pseudoceltites nevadi n. sp.
Tirolites cf. *cassianus* (Quenstedt)
Pseudosageceras multilobatum Noetling

This fauna is of particular interest, as none of the genera are present in the *Prohungerites* fauna of the upper Thaynes Formation in southeast Idaho. The *Subcumbites* fauna from the Tobin Formation of Nevada contains a species of *Ussurites* which, however, is quite distinct from the Confusion Range species. *Pseudoceltites* occurs in the *Owenites* Zone, *Columbites* Zone, and in the latest Scythian *Prohungerites* Zone. One species, *Pseudoceltites dolnopaensis* Kiparisova, is recorded from the *Columbites* Zone of Astakhova (1960b) on the Mangyshlak Peninsula. The *Columbites* fauna of southeast Idaho contains *Pseudoceltites cheneyi* n. sp. which is quite similar to *P. nevadi*. *Tirolites* likewise occurs through the upper half of the Scythian but is of no assistance in the dating of this fauna. Finally, *Pseudosageceras multilobatum* is present in all the Scythian faunal zones.

There are thus few direct data for precise age assignment of this fauna. It represents a distinctive assemblage of species not directly comparable to any other fauna. The stratigraphic position, lying above a horizon with species of *Columbites* Zone age, suggests that we can include this fauna within the late Scythian *Prohungerites* Zone.

Thaynes Formation, Southeast Idaho

The Thaynes Formation of southeast Idaho includes one of the most complete

sequences of ammonoid faunas for the upper half of the Scythian. Extensive data on the stratigraphy and facies relations of the formation have been presented by Kummel (1954, 1957). In the general area of Bear Lake, in southeast Idaho, the Thaynes Formation contains five distinct ammonoid horizons. The basal unit of the formation is the lower limestone member of Kummel (1954) and contains an abundant *Meekoceras* fauna. Immediately overlying the lower limestone member is the lower shale member which contains a well developed *Anasibirites* fauna. There has been considerable debate as to whether these two faunas represent distinct zones or are part of a single zone. Recently, Kummel and Erben (1968) have presented new data that favor considering these two faunal horizons as subzones of the *Owenites* Zone of mid-Scythian age, as originally suggested by Smith (1932). Approximately 620 feet above the lower limestone unit with *Meekoceras*, occurs a small fauna of two species of ammonites: *Tirolites harti* and *Dalmatites attenuatus*. Smith (1932) correlated this fauna with that of the Werfen Formation of the Alps and adjoining regions and established a *Tirolites* Zone. The correlation of this fauna has been discussed in detail on page 342 in conjunction with the discussion of the Werfen fauna. The conclusion arrived at here is that this Idaho fauna is not correlative with the Werfen fauna but is more related to the overlying *Columbites* fauna, and should probably be considered as merely a local subzone of the *Columbites* Zone.

One thousand feet above the lower limestone member with *Meekoceras* is the middle shale member which contains the richly fossiliferous *Columbites* fauna. Smith (1932) described the following species of ammonites in this fauna from outcrops in Paris Canyon:

Ophiceras jacksoni Hyatt and Smith
Ophiceras spencei Hyatt and Smith
Meekoceras curticoelatum Smith

Meekoceras micromphalus Smith
Meekoceras pilatum Hyatt and Smith
Meekoceras sanctorum Smith
Pseudharpoceras idahoense Smith
Tirolites cf. *illyricus* Mojsisovics
Pseudosageceras multilobatum Noetling
Celtites apostolicus Smith
Celtites planovolvis Smith
Celtites ursensis Smith
Columbites consanguineus Smith
Columbites ligatus Smith
Columbites minimus Smith
Columbites oruatus Smith
Columbites parisianus Hyatt and Smith
Columbites speucei Smith

Several new outcrops of the middle shale member have been encountered in the area around Bear Lake in southeastern Idaho, which have yielded an abundance of additional specimens. Examination of all of Smith's types and my own large collections yields the following species as comprising the *Columbites* fauna:

Pseudosageceras multilobatum Noetling
Cordillerites angulatus Hyatt and Smith
Dieneroceras apostolicus (Smith)
Subvishnuites sp. indet.
Xenoceltites speucei (Hyatt and Smith)
Preflorianites montpelierensis n. sp.
Pseudaspilites popovi n. sp.
Columbites parisianus Hyatt and Smith
Pseudoceltites chenevi n. sp.
Svalbardiceras sheldoni n. sp.
Nordophiceras pilatum (Hyatt and Smith)
Nordophiceras jacksoni (Hyatt and Smith)
Keyserlingites stephensoni n. sp.
Tirolites smithi n. sp.
Tirolites astakhovi n. sp.
Tirolites sp. indet.
Hellenites idahoense (Smith)
Dahmatites kittli n. sp.
Ussurites mansfieldi n. sp.

Approximately 1000 feet above the middle shale member with the *Columbites* fauna is a unit consisting of a couple of hundred feet of gray-brown limestones and shales that have yielded the following fauna:

Pseudosageceras drinense Arthaber
Isculitoides hammondi n. sp.
Epiceltites gentii Arthaber
Svalbardiceras sp. indet.
Czekanowskites cf. *decipiens* Mojsisovics
Stacheites sp. indet.
Keyserlingites bearriverensis n. sp.

Keyserlingites bearriverensis n. sp.
Oleucites cf. *spiniplicatus* Mojsisovics
Prohungarites mckelvi n. sp.
Prohungarites gutstadtii n. sp.
Prohungarites sp. indet.

Above this fossiliferous unit with *Prohungarites* are at least 600 feet more of strata, but these are very poorly preserved and have yielded no ammonites. The top contact of the Thaynes Formation is not exposed in the Bear River Range.

SYSTEMATIC PALEONTOLOGY¹

Class CEPHALOPODA Cuvier, 1797
 Subclass AMMONOIDEA Zittel, 1884
 Order PROLECANITIDA Miller and Furnish, 1954
 Superfamily MEDLICOTTIACEAE Karpinsky, 1889
 Family SAGECERATIDAE Hyatt, 1900
 Genus *Pseudosageceras* Diener, 1895
 Type species, *Pseudosageceras multilobatum* Noetling, 1905

No other genus of Scythian ammonoid is as long ranging or as widely and abundantly distributed as *Pseudosageceras*. Approximately a dozen species have been recognized, most of which, however, were based on one or few specimens and are quite restricted in distribution. I recognize within the upper Scythian faunas of the world the following five species:

Pseudosageceras multilobatum Noetling
Pseudosageceras drinense Arthaber
Pseudosageceras albanicum (Arthaber)
Pseudosageceras pasquayi Renz and Renz
Pseudosageceras simplex Kiparisova

Among these species *pasquayi* and *simplex* are known only from single specimens at single localities. The species *albanicum*

¹ Abbreviations in this paper: MCZ = Museum of Comparative Zoology; BMNH = British Museum (Natural History); GSI = Geological Survey of India; PIUV = Paleontological Institute, University of Vienna; GPIBo = Geological Institute, Bonn University; NHMB = Natural History Museum Basel; USNM = United States National Museum; USGS = United States Geological Survey. No data on repository are given for species not personally examined by the author.

is fairly well represented in the *Subcolumbites* fauna of Albania and Chios, as is *drinense*, but the latter species is also known from a single specimen of late Scythian age from southeast Idaho. The above species are only known from uppermost Scythian horizons. The species which is universal in its distribution is *multilobatum*. There are few fossiliferous marine formations of Scythian age that have not yielded specimens of this species.

Pseudosagecceras multilobatum Noetling
Plate 34, figure 6; Text-figure 2

Pseudosagecceras multilobatum Noetling, 1905: 181, pls. 19–27; Frech, 1905: pl. 23, figs. 4, 5, pl. 25, fig. 1, pl. 26, fig. 3; Krafft and Diener, 1909: 145, pl. 21, fig. 5; Wanner, 1911: 181, pl. 7, fig. 4; Diener, 1915: 237; Diener, 1917: 173, pl. 1, fig. 13; Welter, 1922: 94, fig. 3; Diener, 1925: 96, fig. 26; Smith, 1932: 87, pl. 4, figs. 1–3, pl. 5, figs. 1–6, pl. 25, figs. 7–16, pl. 60, fig. 32, pl. 63, figs. 1–6; Kutassy, 1933: 630; Collignon, 1933: 24, pl. 11, fig. 2; Spath, 1934: 54, fig. 6a; Kiparisova, 1947: 127, pl. 25, figs. 3, 4; Kummel, 1954: 185–187; Chao, 1959: 183, pl. 1, figs. 9, 12; Silberling in Hose and Repenning, 1959: 2194; Jeannet, 1959: 30, pl. 6, fig. 1; Tozer, 1961a: 44, pl. 13, figs. 8, 9; Kummel, 1966: 388, pl. 1, figs. 11, 12; Kummel and Erben, 1968: 112, pl. 19, fig. 9; Kummel, 1968b: 489.

Pseudosagecceras intermontanum Hyatt and Smith, 1905: 99, pl. 4, figs. 1–3, pl. 5, figs. 1–6, pl. 63, figs. 1, 2; Mathews, 1929: 3, pl. 1, figs. 18–22; C. Renz, 1945: 301; C. Renz, 1947: 147; Renz and Renz, 1947: 62; Renz and Renz, 1948: 90, pl. 16, figs. 4, 7.

Pseudosagecceras multilobatum var. *giganteum* Kiparisova, 1947: 127, pl. 26, figs. 2–5; Popov, 1961: 13, pl. 2, figs. 1, 2.

Pseudosagecceras cf. *multilobatum*,—Kiparisova, 1961: 30, fig. 3.

Pseudosagecceras schamarensis Kiparisova, 1961: 31, pl. 7, figs. 3, 4.

Pseudosagecceras cf. *clavisellatum*,—Renz and Renz, 1948: 90, pl. 16, fig. 3.

Pseudosagecceras longilobatum Kiparisova and Krishtofovich, 1954: 20, pl. 11, fig. 3; Kiparisova, 1961: 29, pl. 6, figs. 1, 2, text-fig. 2; Popov, 1961: 12, pl. 10, fig. 1, text-fig. 2.

This is without doubt the most common and longest ranging of all Scythian ammonoids. The species *multilobatum* differs from *P. drinense* in the retention of a

narrow tabulate venter; however, the sutures are not all that different. Including *Pseudosagecceras longilobatum* Kiparisova in this species is done mainly on the claim of Popov (1961, p. 13) that the venter on the holotype of *longilobatum* is not preserved, but on the specimen figured by Popov (1961, pl. 10, fig. 1), which has a suture identical to the holotype of *longilobatum*, the venter is tabulate. The lobes and saddles of this species are not much different from those of *multilobatum* (Fig. 2A, I).

Occurrence. Worldwide in distribution, found in all Scythian zones. From the uppermost Scythian, the species is known from the *Subcolumbites* fauna of Chios; the upper Scythian of the Mangyshlak Peninsula; the Narmia Member of the Mianwali Formation in the Surghar Range and Salt Range of West Pakistan; Nifoe-ko, Timor; the *Subcolumbites* fauna of the Primorye Region; the *Olenekites* and *Dieneroceras* zones of the Olenek River region; the *Columbites* fauna of southeast Idaho; the Upper Thaynes Formation, Confusion Range, Nevada; Upper Tobin Formation, south end of Tobin Range, Nevada.

Repository. Specimens from *Columbites* Zone at Montpelier Canyon—suture specimen (Fig. 2C) MCZ 9628, unfigured specimens MCZ 9549; from Hot Springs MCZ 9550; specimens from upper Thaynes Formation, Confusion Range, plesiotype (Pl. 34, fig. 6) USNM 153072; unfigured specimen from Tobin Formation, Nevada, MCZ 9650; from Narmia Member, Mianwali Formation, Salt Range and Surghar Range, West Pakistan, MCZ 9576–9580; from *Subcolumbites* fauna Kotal-e-Tera, Afghanistan, MCZ 10166, 10173; from *Subcolumbites* fauna of Chios, plesiotype *P. intermontanum* (Renz and Renz, 1948: pl. 16, fig. 4) NHMB J13813; (Renz and Renz, 1948: pl. 16, fig. 7) NHMB J13814, unfigured specimens NHMB J13815; *P. cf. clavisellatum* (Renz and Renz, 1948: pl. 16, fig. 3) NHMB J13812; specimen from *Olenekites* Zone, Olenek River region MCZ 8678.

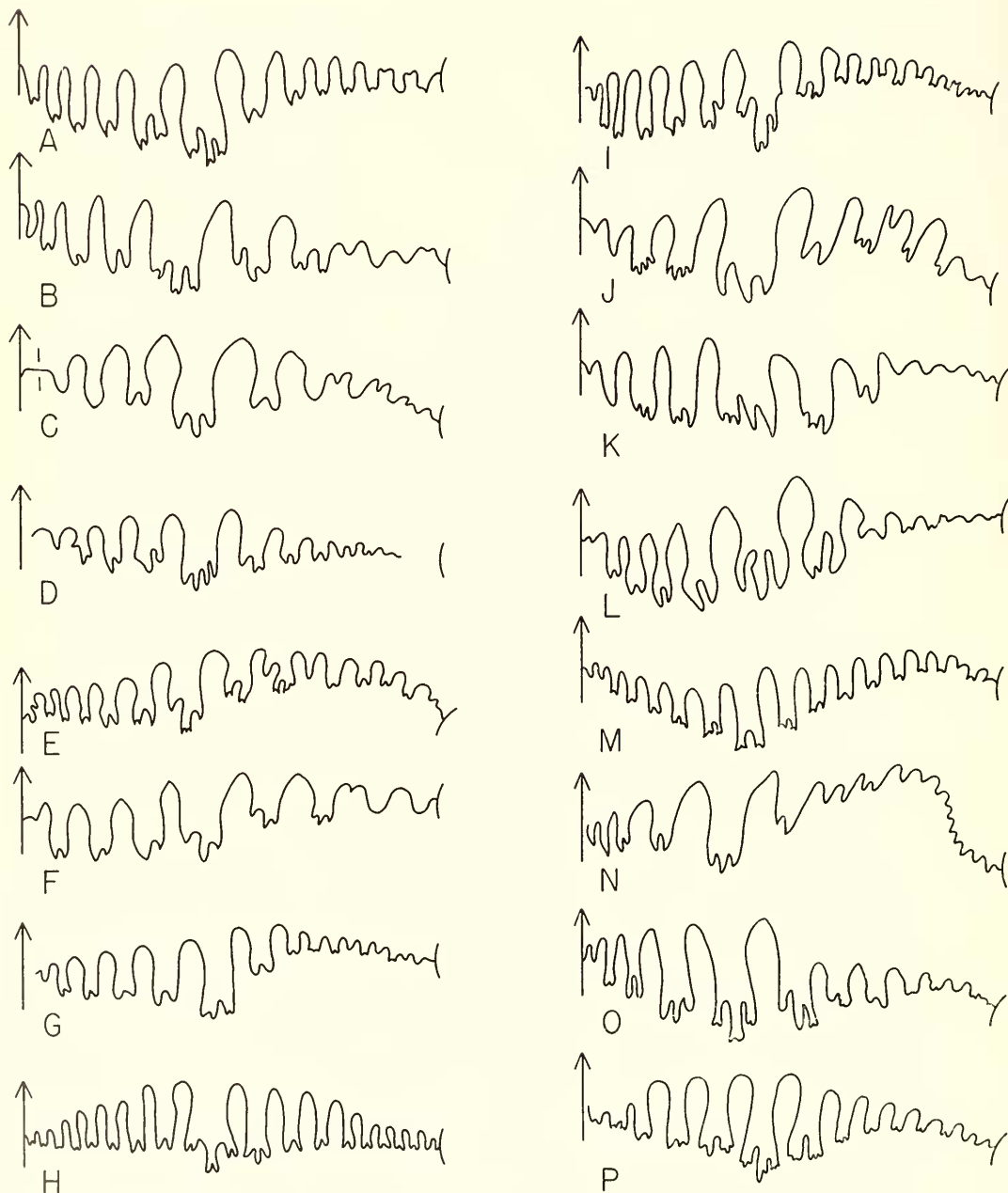


Figure 2. Diagrammatic representation of the suture of: A, *Pseudosageceras multilobatum*,—Krafft and Diener (1909: pl. 21, fig. 5c), from *Hedenstroemia* beds, Muth, Himalayas, at a diameter of approximately 70 mm; B, holotype *Pseudosageceras intermontanum* Hyatt and Smith (1905: pl. 4, fig. 3), from Meekoceras limestone, Thayne's Formation, southeast Idaho, at a diameter of 65 mm; C, *Pseudosageceras multilobatum* Naetling (MCZ 9628), from *Columbites* fauna, Montpelier Canyon, southeast Idaho, at a whorl height of 10.5 mm; D, *Pseudosageceras schamarense* Kiparisova (1961: fig. 4), from mid-Scythian strata in the Primorye Region, at a whorl height of 18 mm; E, *Pseudosageceras drinense* Arthaber (1911: pl. 17(1), fig. 7), from *Subcolumbites* fauna of Albania; F, *Pseudosageceras drinense* Arthaber, from Upper Thayne's Formation, Hammond Creek, southeast Idaho (MCZ 9489), at a whorl height of 13 mm; G, *Pseudosageceras simplex*

Pseudosageceras drinense Arthaber
Plate 12, figures 4, 5; Text-figure 2

Pseudosageceras multilobatum,—Arthaber, 1908: 279, pl. 12(2), figs. 3a–c.

Pseudosageceras drinense Arthaber, 1911: 201, pl. 17(1), figs. 6, 7; Diener, 1915: 236; C. Renz, 1928: 155; Kutassy, 1933: 639; Spath, 1934: 55, fig. 6c; Renz and Renz, 1947: 62; Renz and Renz, 1948: 92, pl. 16, figs. 6–6a.

Pseudosageceras drinense Arthaber var. *incenrolata* Renz and Renz, 1948: 92, pl. 16, figs. 11–11a.

Metahedenstroemia n. sp. Kummel, 1954: 187.

Arthaber (1911: 201) stated he had 13 specimens of this species but only the holotype specimen (Pl. 12, figs. 4, 5) is still preserved. The principal distinguishing feature of this species is the acute venter developed in the later growth stages. The suture (Fig. 2E) is quite similar to that of *Pseudosageceras multilobatum*. A small fragmentary specimen from the upper Thaynes Formation can be assigned to this species. Its suture (Fig. 2F), though taken at a whorl height of 13 mm, is like that of the Albanian specimens.

Occurrence. *Subcolumbites* fauna of Albania and Chios; the upper Thaynes Formation, Hammond Creek, southeast Idaho.

Repository. The holotype is in the Paleontological Institute, Vienna; the British Museum has 15 paratypes BMNH C22984–98, C23002; the figured specimens from Chios (Renz and Renz, 1948: pl. 16, fig. 6) NHMB J13816, unfigured specimens from Maradovuno on Chios NHMB J13817, from Kephlovuno NHMB J13818; the

specimen from southeast Idaho is MCZ 9489.

Pseudosageceras albanicum (Arthaber)
Plate 21, figures 5, 6; Text-figure 2

Sageceras albanicum Arthaber, 1908: 281, pl. 13(3), figs. 1a–c; Arthaber, 1911: 203, pl. 17(1), figs. 4, 5; Diener, 1915: 249; C. Renz, 1928: 155; Kutassy, 1933: 651; Renz and Renz, 1947: 62; Renz and Renz, 1948: 94, pl. 16, figs. 5–5a, 10–10a.

Pseudosageceras albanicum,—Spath, 1934: 56, fig. 6b.

Arthaber (1911: 203) stated he had 15 specimens of this species. There is today in the Paleontological Institute, Vienna, only the holotype figured by Arthaber and also figured here (Pl. 21, figs. 5, 6). This specimen measures 64.3 mm in diameter, 12 mm for the width of the adoral whorl, and approximately 40 mm for the height of the adoral whorl. Arthaber's representation of the suture (Fig. 2M) is accurate. The principal distinguishing feature of this species is its suture.

Occurrence. *Subcolumbites* fauna of Albania and Chios.

Repository. The holotype is in the Paleontological Institute, Vienna; the British Museum has 13 paratypes BMNH C22999–23001, 23003–12; the plesiotypes from Chios (Renz and Renz, 1948: pl. 16, fig. 5) NHMB J13821, (Renz and Renz, 1948: pl. 16, fig. 10) NHMB J13822; unfigured specimens from Maradovuno NHMB J13823, from Kephlovuno NHMB J13824.

←

Kiparisova (1961: fig. 1), from *Subcolumbites* fauna, Primorye Region, Siberia, at a whorl height of 14.5 mm; H, *Pseudosageceras pasquayi* Renz and Renz (1948: pl. 16, fig. 2b), from *Subcolumbites* fauna of Chios, at a diameter of 35 mm; I, *Pseudosageceras longilobatum* Kiparisova (1961: fig. 2), from *Subcolumbites* fauna of Primorye Region, Siberia, at a whorl height of 19 mm; J, holotype, *Pseudosageceras tsotengense* Chao (1959: fig. 5b), from Owenites zone, Kwangsi, China, at a diameter of approximately 30 mm; K, *Pseudosageceras longilobatum* var. *kwangsiense* Chao (1959: fig. 5c), from Owenites Zone, Kwangsi, China, at a diameter of approximately 35 mm; L, *Pseudosageceras compressus* (Mathews, 1929: pl. 1, fig. 17), from *Anasibibites* fauna, Fort Douglas, Utah, at a diameter of approximately 20 mm; M, *Pseudosageceras albanicum* (Arthaber, 1911: pl. 17(1), fig. 5), from *Subcolumbites* fauna of Albania at a diameter of 55 mm; N, holotype *Pseudosageceras curvatum* Chao (1959: fig. 52), from *Flemingites* fauna, Kwangsi, China, at a diameter of approximately 70 mm; O, *Pseudosageceras* cf. *clavisellatum*, Renz and Renz (1948: pl. 16, fig. 3a), from *Subcolumbites* fauna of Chios, at a diameter of 24 mm; P, *Pseudosageceras clavisellatum* Diener (1913: pl. 4, fig. 5c), from *Opficeras* layer, Pastannah, Kashmir, at a diameter of approximately 30 mm.

***Pseudosageceras pasquayi* Renz and Renz**
Text-figure 2*Pseudosageceras* (*Metasageceras*) *pasquayi* Renz and Renz, 1947: 62, 79; Renz and Renz, 1948: 93, pl. 16, fig. 2.*Pseudosageceras pasquayi*,—Kummel, in Arkell et al., 1957: L75.

A species based on a single specimen, distinctive for its unusual suture (Fig. 2H). The holotype measures 37.7 mm in diameter, 6.3 mm for the width of the adoral whorl, 22.5 mm for the height.

Occurrence. *Subcolumbites* fauna, Chios.*Repository.* Holotype NHMB J13820.***Pseudosageceras simplex* Kiparisova**
Text-figure 2*Pseudosageceras simplex* Kiparisova, 1947: 128, pl. 25, fig. 2, text-fig. 6; Kiparisova, 1961: 28, pl. 6, fig. 3, text-fig. 1.

Another species established for a single incomplete specimen. Its special features are a narrow rounded venter and a quite simple suture (Fig. 2G). The suture is very much like that of *P. albanicum* except for its lack of curvature (Fig. 2G, M). It is highly possible that this difference is not of specific importance and that additional samples of each of these species would show the curvature and alignment of the suture to be highly variable.

Occurrence. *Subcolumbites* Zone, Pri-morye Region, Siberia.**Genus *Cordillerites* Hyatt and Smith, 1905**
Type species, *Cordillerites angulatus* Hyatt and Smith, 1905***Cordillerites angulatus* Hyatt and Smith**
Plate 20, figures 5, 6; Plate 51, figures 6, 7; Text-figure 3*Cordillerites angulatus* Hyatt and Smith, 1905: 110, pl. 2, figs. 1–8, pl. 68, figs. 1–10, pl. 71, figs. 1–6, pl. 85, figs. 14–20; Frech, 1908: pl. 63, fig. 2; Diener, 1915: 112; Diener, 1917: 175, pl. 1, fig. 11; Smith, 1932: 96, pl. 2, figs. 1–8, pl. 42, figs. 14–20, pl. 60, fig. 14, pl. 68, figs. 1–10, pl. 71, figs. 1–6; Spath, 1934: 61; C. Renz, 1947: 176; Kummel, in Arkell, et al., 1957: L75.*Hedenstroemia skipetarensis* Arthaber, 1911: 208, pl. 17(1), fig. 13.TABLE 23. MEASUREMENTS OF 15 SPECIMENS ASSIGNED TO *CORDILLERITES ANGULATUS* HYATT AND SMITH.

	D	W	H	U	W/D	H/D	U/D
1.	97.0	28.0	59.4	0	28.9	61.2	0
2.	42.0	14.0	28.0	0	33.3	66.6	0
3.	35.0	10.0	23.0	0	28.6	65.9	0
4.	35.0	11.0	22.4 [?]	0	31.4	64.0 [?]	0
5.	33.0	6.3 [?]	20.0	0	19.1	60.6	0
6.	29.5	5.8	17.4 [?]	0	19.7	59.0 [?]	0
7.	24.2	6.2	15.6	0	25.6	64.5	0
8.	22.6	5.3	13.7	0	23.5	60.6	0
9.	22.0	4.5 [?]	13.4	0	20.5	60.9	0
10.	21.3	5.3	14.0	0	24.9	65.6	0
11.	19.4	4.7	12.0 [?]	0	24.2	61.9 [?]	0
12.	15.8	4.1	9.4	0	25.9	59.5	0
13.	15.3	4.0	9.4	0	26.1	61.5	0
14.	14.4	4.5	9.3	0	31.1	64.5	0
15.	14.2	3.1	8.0	0	21.8	56.4	0

1. Paralectotype, Hyatt and Smith (1905: pl. 68, figs. 1–3).
2. Holotype, *Pseudosageceras bicarinatum* Tozer (1965: 16).
3. Paralectotype, Hyatt and Smith (1905: pl. 2, figs. 4, 5).
4. Lectotype, Hyatt and Smith (1905: pl. 2, figs. 1–3).
5. Plesiotype (Pl. 51, fig. 1), MCZ 9569.
6. 10, 15. Specimens from *Columbites* fauna, Bear Lake region, southeast Idaho.
7. Paralectotype, Hyatt and Smith (1905: pl. 68, figs. 8–10).
8. Plesiotype,—Renz and Renz (1948: pl. 16, fig. 9).
9. 13. Unfigured specimens from Chios, NHMB.
11. Paralectotype, Hyatt and Smith (1905: pl. 2, fig. 6).
12. Holotype, *Hedenstroemia skipetarensis* Arthaber (1911: pl. 17(1), fig. 13).
14. Paralectotype, Hyatt and Smith (1905: pl. 42, figs. 14–16).

Epihedenstroemia skipetarensis,—Spath, 1934: 222, fig. 71.cf. *Cordillerites angulatus*,—Renz and Renz, 1947: 67; Renz and Renz, 1948: 88, pl. 16, fig. 9.*Cordillerites kwangsiensis* Chao, 1959: 33, 188, pl. 44, figs. 7, 8, text-fig. 6b; Kummel and Steele, 1962: 645.*Cordillerites orientalis* Chao, 1959: 34, 188, pl. 1, figs. 10, 11, text-fig. 6a.*Pseudosageceras bicarinatum* Tozer, 1965a: 16, pl. 2, figs. 8a–d, text-fig. 1.

Cordillerites up until now has been known only through its type species, *C. angulatus*, from the *Meekoceras* limestone of southeast Idaho. The description and illustrations of this species by Hyatt and Smith (1905) and Smith (1932) are quite adequate. The measurements of the specimens assigned to this species are given on Table 23.

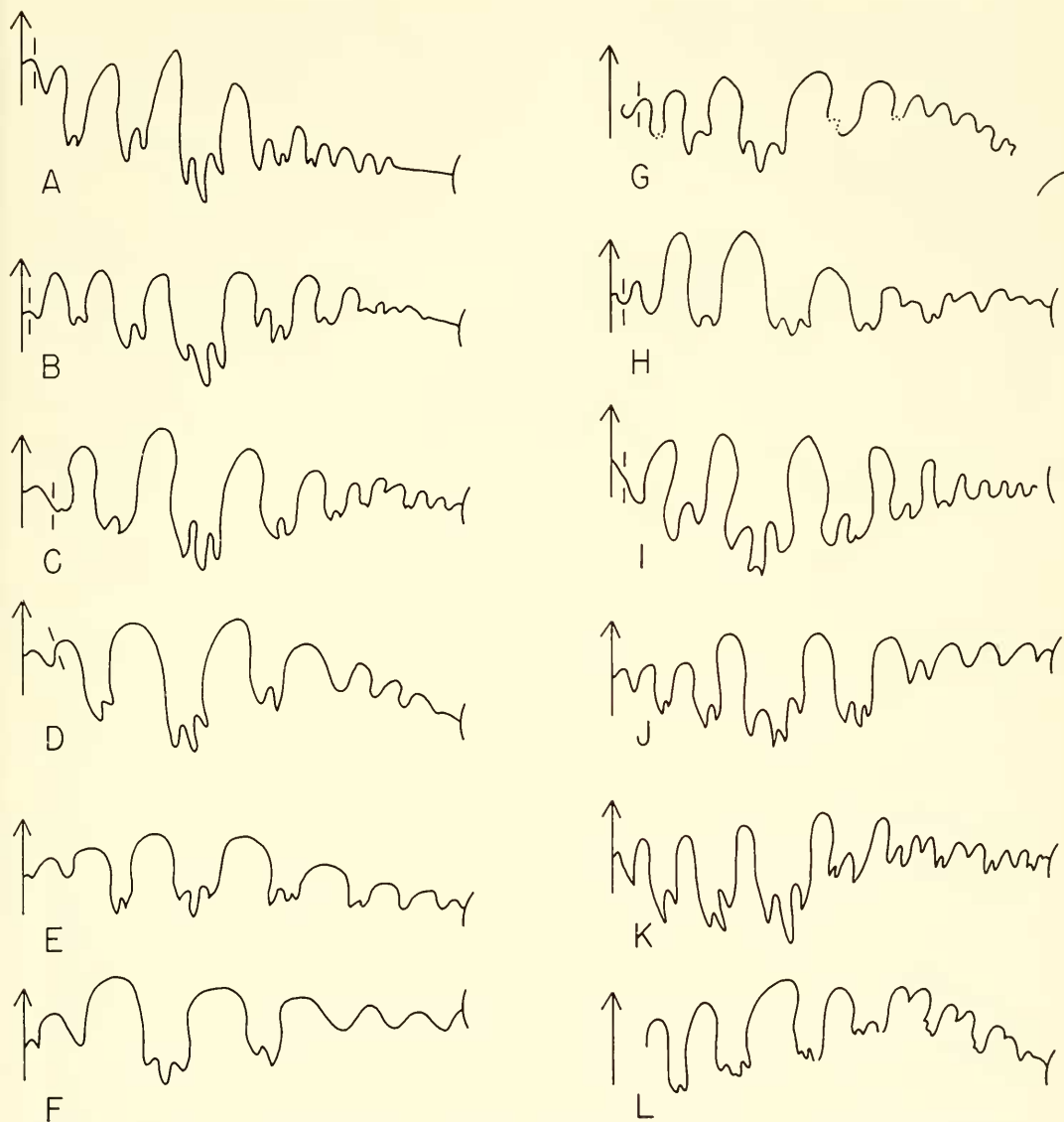


Figure 3. Diagrammatic representation of the sutures of two species of *Cardillerites*. A–K, *Cardillerites angulatus* Hyatt and Smith; A, paralectotype, at a diameter of 90 mm (Hyatt and Smith, 1905: pl. 68, fig. 3, USNM 75300a); B, paralectotype, at a diameter of 80 mm (Hyatt and Smith, 1905: pl. 68, fig. 6, USNM 75300b); C, lectotype, at a diameter of 35 mm (Hyatt and Smith, 1905: pl. 2, fig. 3, USNM 75247a); D, paralectotype, at a diameter of 25 mm (Hyatt and Smith, 1905: pl. 68, fig. 10, USNM 75300c); E, paralectotype, at a diameter of 17 mm (Hyatt and Smith, 1905: pl. 71, fig. 5); F, paralectotype, at a diameter of 10 mm (Hyatt and Smith, 1905: pl. 71, fig. 2); G, holotype of *Hedenstroemia skipetarensis* Arthaber (1911: pl. 17[1], fig. 13), new drawing at a diameter of 15.7 mm; H, specimen from *Columbites* Zone, southeast Idaho, at a diameter of 29 mm (MCZ 9569); I, cf. *Cardillerites angulatus*,—Renz and Renz (1948: pl. 16, fig. 9b), at a diameter of approximately 20 mm; J, holotype *C. orientalis* Chao (1959: fig. 6a), at a diameter of 55 mm; K, holotype *C. kwangsiensis* Chao (1959: fig. 6b), at a diameter of 19 mm; L, *Cardillerites concinnus* Kiparisova (1961: fig. 5), at a diameter of 42 mm.

Specimens of figures A–F, from *Meekoceras* fauna of southeastern Idaho; G, from *Subcolumbites* fauna of Albania; H, *Columbites* fauna of southeastern Idaho; I, from *Subcolumbites* fauna of Chios; J, from *Subcolumbites* fauna of Kwangsi, China; K, from *Owenites* fauna of Kwangsi, China; L, from the *Proptychites* Zone of the Primorye Region.

The *Columbites* fauna of southeast Idaho has yielded six specimens of this species. One of them is illustrated here on Plate 51, figures 6, 7 and its suture on Figure 3H. These specimens agree remarkably with all the essential features of the types from the *Meekoceras* limestone.

Hedenstroemia skipetarensis Arthaber (1911: 208) was established for a small, involute, compressed specimen of 15.8 mm in diameter (Pl. 20, figs. 5, 6). Arthaber (1911) considered this small specimen to be unique and possibly deserving separate generic status. Spath (1934: 222) established the genus *Epihedenstroemia* with *Hedenstroemia skipetarensis* Arthaber as type. The uniqueness of the species centers around the curvature of the suture as depicted by Arthaber (1911: pl. 17(1), fig. 13c). Re-examination of Arthaber's type specimen clearly shows that this representation of the suture was not one of the most successful in his monograph. A new drawing of the suture of this type specimen is shown here on Figure 3G. The suture is nearly identical to the suture of the American specimens of *Cordillerites angulatus* from the *Meekoceras* limestone at a diameter of 17 mm (Fig. 3E) and 25 mm (Fig. 3D). The shape of the conch, nature of the venter, etc., also fit in perfectly with the American type specimens. The *Subcolumbites* fauna of Chios also contains this species. Renz and Renz (1948: 89) had one specimen they assigned to this species with the symbol "cf." There are in addition four specimens from the *Subcolumbites* fauna of Chios in the Natural History Museum, Basel. The suture (Fig. 3I), as noted by Renz and Renz (1948: 89), is very much like that of the lectotype (Fig. 3C). There is no question but that these *Subcolumbites* fauna specimens from Chios are conspecific with the American type specimens.

Tozer (1965a: 16), in the discussion of his new species *Pseudosagecceras bicarinatum*, stressed the possible affinities of

his species with *Hedenstroemia skipetarensis* Arthaber. The suture of Tozer's specimen is nearly identical to that of *C. angulatus* illustrated by Hyatt and Smith (1905: pl. 68, fig. 6; Fig. 3B of this report). The general shape of the conch, etc., fits in perfectly.

The descriptions and illustrations of *Cordillerites kwangsiensis* Chao (1959) from the *Owenites* Zone, Kwangsi, China, and *Cordillerites orientalis* from the *Subcolumbites* fauna of Kwangsi, China, leave much to be desired. The first of these species was based on a single specimen, the second on only two. The sutures of these species (Figs. 3J, K) are very comparable to the mature sutures of the American type specimens (Figs. 3A, B). I can find no justification for not considering these two species as synonyms of *Cordillerites angulatus*.

The only other species of *Cordillerites* recognized here is *C. concinnus* Kiparisova from the early Scythian *Proptychites* Zone of Kiparisova (1961: 33) in the Primorye Region, Siberia. This species differs mainly in the nature of its suture.

Cordillerites compressus Mathews (1929: 3) from the *Anasibirites* fauna of Fort Douglas, Utah, had been accepted as a valid species of *Cordillerites* by Smith (1932) and Spath (1934). On the basis primarily of the much greater elaboration of the suture, I consider this to be a species of *Pseudosagecceras*.

Occurrence. This species is now known from the mid-Scythian *Meekoceras* Zone of southeast Idaho and the equivalent horizon in Kwangsi, China (Chao collection 542b); from the *Columbites* fauna of southeast Idaho; from the *Subcolumbites* fauna (or its equivalent) in Albania, Chios, Kwangsi, and British Columbia.

Repository. The new specimens from the *Columbites* fauna of southeast Idaho recorded here are MCZ 9569 (Pl. 51, figs. 5, 6), unfigured specimens from Hot Springs MCZ 9627.

Order CERATITIDA Hyatt, 1884

Superfamily OTOCERATAEAE Hyatt, 1900

Family DIENEROCERATIDAE Kummel, 1952

This family was originally introduced for the single genus *Dieneroceras* which is interpreted as a persisting stock of the ophiceratids and a probable root of later ornamented stocks. *Dieneroceras* is one of the simplest of Scythian ammonoids and quite common throughout the Scythian. Included in the family are *Subvishnuites* and *Hemilecanites*. Both of these genera are much like *Dieneroceras* in the simplicity of their sutures and conch form. They are characterized by acute venters; *Subvishnuites* has a more inflated whorl section; *Hemilecanites* a highly compressed whorl section. *Hemilecanites* is restricted to the late Scythian *Prohungarites* Zone; *Dieneroceras* and *Subvishnuites* are quite common in mid-Scythian faunas.

Genus *Dieneroceras* Spath, 1934

Type species, *Ophiceras dieneri* Hyatt and Smith, 1905

This genus is not nearly as common nor as widely distributed in the late Scythian as it is in the Owenites Zone of mid-Scythian age. There are two species (*D. mediterranea*, *D. skutarensis*) represented by few specimens in the *Subcolumbites* faunas of Albania and Chios. The correlative fauna in the Primorye Region contains a single specimen assigned to *D. karazini* n. sp. In the underlying *Columbites* Zone there are only two species: *D. demokidovi* from northern Siberia, and *D. apostolicus* from southeast Idaho and northern Siberia.

Dieneroceras mediterranea (Arthaber)

Plate 4, figures 7–10; Plate 19, figures 3, 4; Text-figure 4.

Xenaspis mediterranea Arthaber, 1908: 260, pl. 11(1), figs. 3a–e; Arthaber, 1911: 231; Diener, 1915: 311; Spath, 1934: 134, 136, 293.

Celtites keirensis Arthaber, 1908: 273, pl. 11(1), figs. 8a–c; Diener, 1915: 75; Renz and Renz, 1948: 42, pl. 3, fig. 6 (non 3).

Xenodiscus keirensis (Arthaber) 1911: 181.

Ophiceras sakuntala Arthaber (non Diener), 1911: 239, pl. 21(5), fig. 4.

Ophiceras cf. *sakuntala* Diener, 1915: 212.

The type specimen measures 53.7 mm in diameter, 11.4 mm for the width of the last whorl, 13.8 mm for the height, and 26.5 mm for the diameter of the umbilicus. The whorls are subtrapezoidal in cross-section, the flanks converging slightly towards a low, arched venter. The ventral and umbilical shoulders are rounded. The specimen had been ground and polished on part of the phragmocone to expose the suture, but in this case I do not believe there is any appreciable distortion to the suture. A new drawing of this suture is shown on Figure 4A.

The specimen Arthaber (1908: 273) assigned to *Celtites keirensis* is a small individual with the following measurements: Diameter 28.8, Width 8.8, Height 9.3, Umbilicus 12.8 mm. The apparent sharpening of the venter in the adoral quarter volution I believe is due to factors of preservation and is not the true outline of the whorl at that stage (Pl. 4, figs. 9, 10). The suture is identical to that of the type specimen. The specimen clearly is a juvenile form of *D. mediterranea*. A comparable specimen from the *Subcolumbites* fauna of Chios was assigned by Renz and Renz (1948: 42, pl. 3, fig. 6) to *Celtites keirensis*, and this I believe also to be a juvenile form of *D. mediterranea*. One of the specimens from Chios that Renz and Renz (1948: 42, pl. 3, fig. 3) assigned to *Celtites keirensis* is a specimen of *Hemilecanites discus*.

The specimen Arthaber assigned to *Ophiceras sakuntala* Diener is incomplete and slightly crushed (Pl. 19, figs. 3, 4). Direct comparison of this specimen with the other specimens assigned to *D. mediterranea* convinces me that they are conspecific.

Occurrence. *Subcolumbites* fauna of Albania and Chios.

Repository. The Paleontological Institute of Vienna has the holotype of *Xenaspis*

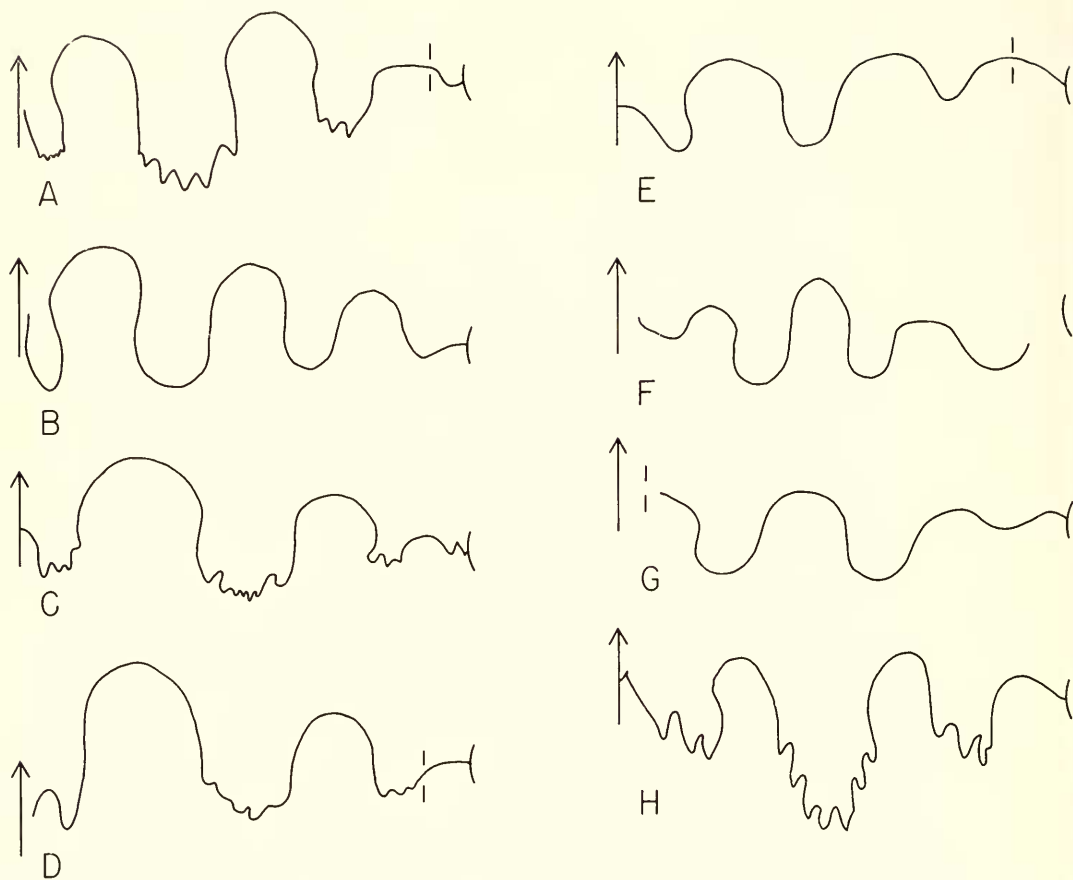


Figure 4. Diagrammatic representation of the suture of: A, holotype, *Dieneroceras mediterranea* (Arthaber, 1908: pl. 11(1), figs. 3a-c), from *Subcolumbites* fauna of Albania, new drawing at a diameter of 36 mm; B, holotype *Dieneroceras skutarensis* (Arthaber, 1911: pl. 21(5), fig. 1), from *Subcolumbites* fauna of Albania, at a diameter of 18 mm; the goniatitic aspect of the lobes is most probably due to excessive grinding in the preparation of the specimen; C, *Dieneroceras demokidovi* Popov (1961: fig. 6f), from "Dieneroceras" Zone, Olenek River basin, Siberia; D, *Dieneroceras karazini* nov. nom. (Kiparisava, 1961: fig. 14), from *Subcolumbites* fauna, Primorye Region, Siberia, at a whorl height of 7 mm; E, holotype *Hemilecanites discus* (Arthaber, 1908: pl. 11(1), fig. 5), from *Subcolumbites* fauna of Albania at a diameter of approximately 20 mm; F, paratype *Hemilecanites paradiscus* n. sp. from *Subcolumbites* fauna of Tobin Formation, Nevada, at a diameter of 16 mm (MCZ 9631); G, paratype *Hemilecanites paradiscus* n. sp. from *Subcolumbites* fauna of Tobin Formation, Nevada, at a diameter of 14 mm (MCZ 9483); H, holotype *Xenaspis enveris* Arthaber (1911: pl. 20(4), fig. 3), from *Subcolumbites* fauna of Albania.

mediterranea and *Celtites kcirensis*, and the plesiotype of *Ophiceras sakuntala* Arthaber (non Diener). The plesiotype of *Celtites kcirensis* from Chios is NHMB J13654.

Dieneroceras skutarensis (Arthaber)

Plate 20, figures 3, 4; Text-figure 4

Lecanites skutarensis Arthaber, 1911: 237, pl. 21(5), fig. 1; Spath, 1934: 135, 136; Renz

and Renz, 1947: 61; Renz and Renz, 1948: 55, pl. 3, fig. 5.
Proavites skutarensis,—Diener, 1915: 228.

This is a dieneroceratid very much on the pattern of *Dieneroceras knechti* (Hyatt and Smith) from the *Owenites* Zone; it could possibly be conspecific with that species. However, because of the smallness of the sample available, a tendency for *D. sku-*

taurensis to have a slightly more inflated whorl section, and the great age difference between these forms I believe it best to recognize the independent status of this species. Another factor is the goniatic character of the lobes (Fig. 4B). The specimen has been excessively ground and polished to expose the suture, and this could entirely account for the smooth lobes.

Occurrence. *Subcolumbites* fauna of Albania and Chios.

Repository. The holotype, and only specimen from Albania, is in the Paleontological Institute, Vienna. The figured specimen from Chios (Renz and Renz, 1948: pl. 3, fig. 5) is NHMB J13700, unfigured specimens from Maradovuno NHMB J13701, from Kephlovuno NHMB J13702. The MCZ has three specimens from Chios, MCZ 10027, 10029.

Dieneroceras karazini n. sp.

Text-figure 4

Dieneroceras dieneri Kiparisova (non Hyatt and Smith) 1961: 47, pl. 9, fig. 2.

Kiparisova had only a single specimen of this species and this is indeed quite similar to *D. dieneri*. However, because of the great difference in age of the American *D. dieneri* (*Owenites* fauna) and the Primorye specimen (*Subcolumbites* fauna) I believe it best to consider them as separate species. There are differences in involution, shape of the whorl section and suture (Fig. 4D), but the smallness of the sample prevents any evaluation of these differences.

Occurrence. Primorye Region, from *Subcolumbites* fauna between Cape Mushketov and Cape Karazin.

Dieneroceras demokidovi Popov

Text-figure 4

Dieneroceras demokidovi Popov, 1961: 36, pl. 12, figs. 1, 5.

Dieneroceras nikabitensis Popov, 1962a: 184, pl. 3, fig. 1.

The conch of this species is very much on the pattern of that of *D. knechti* from the *Owenites* Zone, except that the whorls are slightly more inflated. The conch is apparently completely smooth. It is really only in the smoothness of the conch that one can readily separate this species from *D. apostolicus*. The suture is illustrated on Figure 4C.

Occurrence. *Dieneroceras* Zone of Popov (1961) from a number of localities in the Olenek and Kolyma river basins, Siberia.

Repository. Popov's specimens are in the Tchernyshev Central Geological Museum of Leningrad. The Museum of Comparative Zoology has three topotype specimens, MCZ 6105, 6106, 8679.

Dieneroceras apostolicus (Smith)

Plate 53, figures 1–12; Text-figures 5, 6

Celtites apostolicus Smith, 1932: 104, pl. 48, figs. 1–10.

"*Celtites*" *apostolicus*,—Kummel, 1954: 187; Kummel, 1961: 519.

Dieneroceras apostolicus,—Popov, 1961: 37, pl. 12, fig. 6.

Celtites planovolvis Smith, 1932: 104, pl. 48, figs. 11–20.

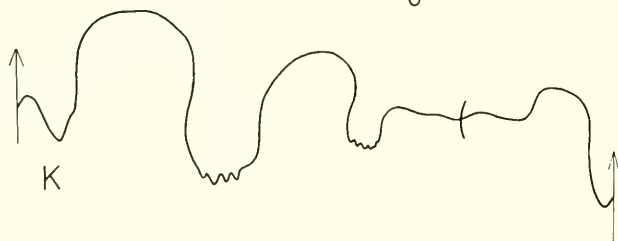
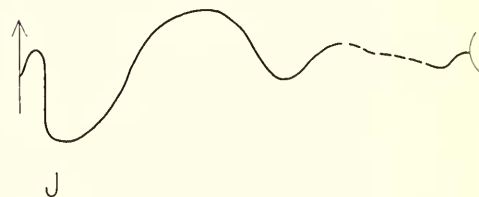
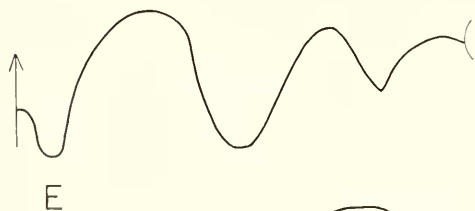
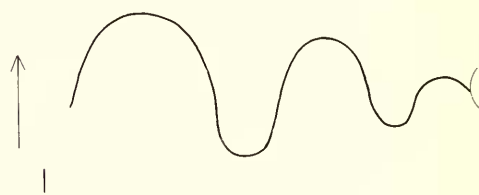
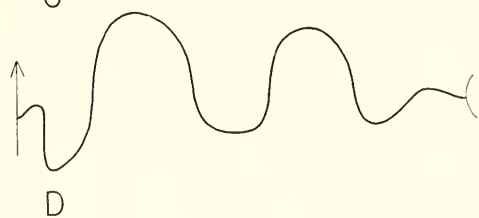
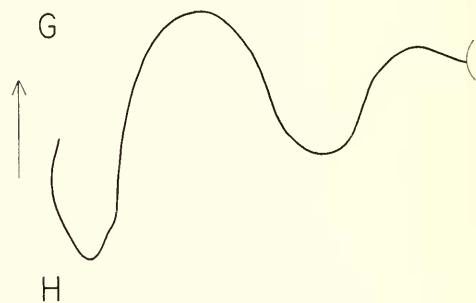
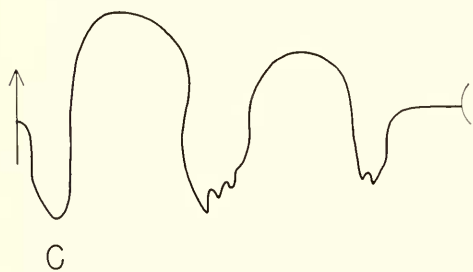
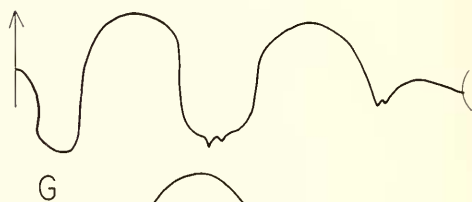
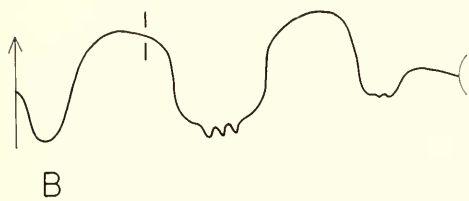
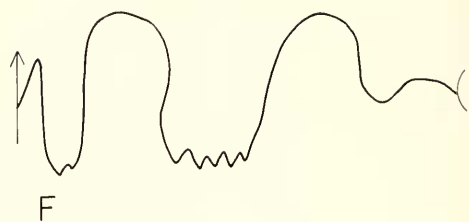
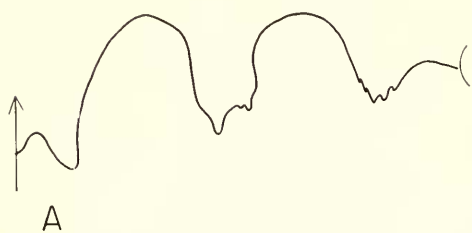
"*Celtites*" *planovolvis*,—Kummel, 1954: 181; Kummel, 1961: 519.

Celtites ursensis Smith, 1932: 104, pl. 47, figs. 11–23.

"*Celtites*" *ursensis*,—Kummel, 1954: 187; Kummel, 1961: 519.

Dieneroceras khelaliensis Popov, 1961: 37, pl. 12, fig. 4.

Smith's (1932) analysis and description of his three species of *Celtites* were not the most successful of his efforts. The three species were differentiated on slight differences in height and width of the whorls. The measurements of 50 specimens from the *Columbites* fauna of southeastern Idaho are listed on Table 24 and plotted on Figure 6. It can readily be seen that the umbilical diameter and whorl height show only a small range of variability, clearly intra-specific. Smith (1932: 104) likewise stated the suture to be goniatic. The sutures of six specimens plus five sutures reproduced by Smith (1932) are shown on Figure 5.



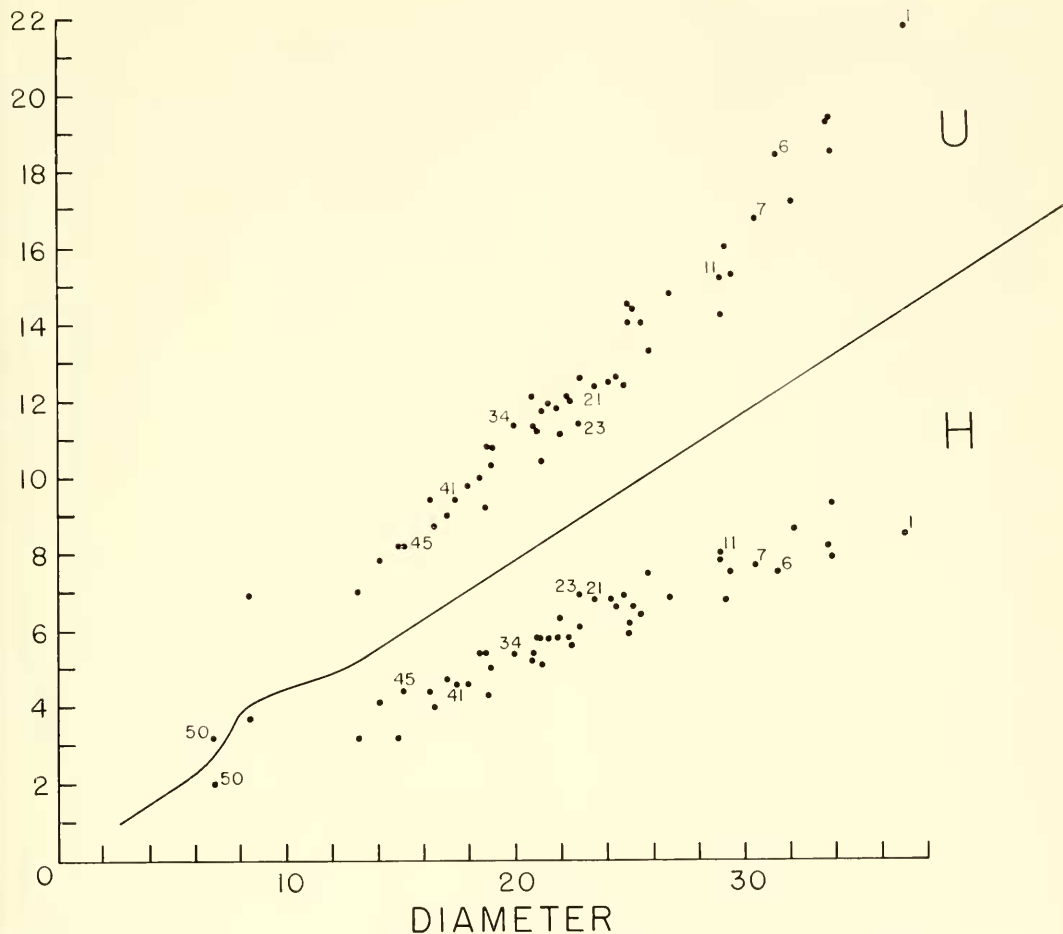


Figure 6. Variation in umbilical diameter (U) and whorl height (H) of *Dieneroceras apostolicus* (Smith) from *Columbites* fauna of Bear Lake region, southeast Idaho. The data on this graph are from Table 24.

All the specimens I studied have denticulated lobes. It should be remarked, however, that the preservation in dense, fine grained, black limestone often makes fine details of the suture very hard to observe.

One additional factor of the suture is the great variability in the shape and size of the various elements.

Smith noted the weak, forward projecting constrictions; however, these are absent

←

Figure 5. Diagrammatic representation of the sutures of *Dieneroceras apostolicus* (Smith). A, at a diameter of 14.2 mm (MCZ 9524); B, at a diameter of 16.3 mm (MCZ 9525); C, at a diameter of 24.1 mm (MCZ 9526); D, at a diameter of 18 mm (USNM 74989c), from Smith (1932: pl. 48, fig. 7); E, at a diameter of 7 mm (USNM 74989d), from Smith (1932: pl. 48, fig. 10); F, at a diameter of 20.9 mm (MCZ 9527); G, at a diameter of 15 mm (MCZ 9528); H, at a diameter of 5.5 mm (USNM 74987e), from Smith (1932: pl. 47, fig. 23); I, at a diameter of approximately 22 mm (USNM 74987c), from Smith (1932: pl. 47, fig. 17); J, at a diameter of 15 mm (USNM 74988c), from Smith (1932: pl. 48, fig. 16); K, at a whorl height of 5.2 mm (MCZ 9529). All specimens from *Columbites* fauna, Thaynes Formation of southeast Idaho; specimens A, C, F, K from Montpelier Canyon; B, G, from Hot Springs; D, E, H, I, J from Paris Canyon.

TABLE 24. MEASUREMENTS OF *DIENEROCERAS APOSTOLICUS* (SMITH) FROM *COLUMBITES* FAUNA AROUND NORTH END OF BEAR LAKE, SOUTHEAST IDAHO.

No.	D	W	H	U	W/D	H/D	U/D	No.	D	W	H	U	W/D	H/D	U/D
1.	37.0?	9.2	8.5	21.8	24.9?	22.9	58.9	26.	22.0	7.7	6.3	11.1	35.0	28.6	50.5
2.	33.8	8.1	9.3	18.5	23.9	27.5	54.7	27.	21.8	5.0	5.8	11.8	22.9	26.6	54.1
3.	33.7	7.9	7.9	19.4	25.4	25.4	57.5	28.	21.4	6.3	5.8	11.9	39.4	27.1	56.2
4.	33.6	7.5	8.2	19.3	27.3	24.4	57.5	29.	21.2	7.1	5.1	11.7	33.5	24.0	55.2
5.	32.2	?	8.6	17.2	—	26.7	53.5	30.	21.1	5.8	5.8	10.4	27.5	27.5	49.3
6.	31.5	7.9	7.5	18.4	25.1	23.8	58.4	31.	21.0	5.2	5.8	11.2	24.8	27.6	53.4
7.	30.5	8.7	7.7	16.7	28.5	25.2	21.9	32.	20.8	5.7	5.4	11.3	27.4	25.9	54.3
8.	29.4	6.8	7.5	15.3	23.1	25.5	52.0	33.	20.7	6.1	5.2	12.1	38.4	25.1	58.5
9.	29.2	6.8	6.8	16.0	23.3	23.3	54.8	34.	20.0	8.3	5.4	11.4	41.5	27.0	57.0
10.	29.0	6.6	7.8	14.2	22.7	26.8	49.0	35.	19.0	5.5	5.0	10.8	28.9	26.3	56.9
11.	29.0	8.4	8.0	15.2	28.9	27.6	52.4	36.	19.0	7.4	5.0	10.3	38.9	36.3	54.2
12.	26.7	7.0	6.8	14.8	26.2	25.4	57.6	37.	18.8	7.0	4.3	10.8	37.2	22.8	57.5
13.	25.8	6.0	7.5	13.3	23.2	29.0	51.6	38.	18.7	5.7	5.4	9.2	30.5	28.9	49.1
14.	25.5	6.3	6.4	14.0	24.7	27.2	54.9	39.	18.5	6.4	5.4	10.0	34.6	29.2	54.0
15.	25.2?	7.7	6.6	14.4	30.5	25.2	57.2	40.	18.0	5.0	4.6	9.8	27.7	25.5	54.4
16.	25.0	?	6.2	14.0	—	24.8	56.0	41.	17.5	5.5	4.6	9.4	31.4	26.3	53.7
17.	25.0	6.5	5.9	14.5	26.0	23.6	58.0	42.	17.1	5.3	4.7	9.0	31.0	27.5	52.5
18.	24.7	7.5	6.9	12.4	31.6	24.3	50.2	43.	16.5	4.6	4.0	8.7	27.8	24.2	54.3
19.	24.4	6.1	6.6	12.6	25.0	27.1	51.7	44.	16.3	5.0	4.4	9.4	30.6	27.0	57.7
20.	24.2	7.0	6.8	12.5	28.9	28.1	51.6	45.	15.2	5.5	4.4	8.2	36.2	28.9	53.9
21.	23.5	8.8	6.8	12.4	37.4	28.9	52.8	46.	14.9	5.8	3.2	8.2	38.9	21.4	55.0
22.	22.8	5.8	6.1	12.6	25.4	26.7	55.3	47.	14.1	6.5	4.1	7.8	46.1	29.0	55.3
23.	22.7	6.5	6.9	11.4	28.6	30.4	50.2	48.	13.2	5.6	3.2	7.0	42.4	24.2	53.0
24.	22.4	?	5.6	12.0	—	25.0	53.7	49.	8.4	4.6	3.7	6.9	54.8	44.1	82.2
25.	22.3	5.8	5.8	12.1	26.0	26.0	54.3	50.	6.9	3.8	2.0?	3.2	55.1	28.9?	46.4

1. Paratype, *Celtites ursensis* Smith (1932: pl. 47, figs. 13, 14), USNM 74987b.

2. Holotype (Smith, 1932: pl. 48, figs. 1, 2), USNM 74989a.

7. Holotype, *Celtites ursensis* Smith (1932: pl. 47, figs. 11, 12), USNM 74987a.11. Paratype, *Celtites ursensis* Smith (1932: pl. 47, figs. 15, 16), USNM 74987c.21. Holotype, *Celtites planovolvis* Smith (1932: pl. 48, figs. 11, 12), USNM 74988a.

23. Paratype (Smith, 1932: pl. 48, figs. 3, 4), USNM 74989b.

34. Paratype, *Celtites planovolvis* Smith (1932: pl. 48, figs. 13, 14), USNM 74988b.

41. Paratype (Smith, 1932: pl. 48, figs. 5-7), USNM 74989c.

45. Paratype, *Celtites ursensis* Smith (1932: pl. 47, figs. 18, 19), USNM 74987d.

50. Paratype (Smith, 1932: pl. 48, figs. 8-10), USNM 74987d.

completely on a large number of specimens, and it is quite clear that this is a highly variable feature. This feature would generally suggest relationship to *Xenoceltites*; however, in this case the whole aspect of the whorls is different from that of "typical" xenoceltitids.

Even though the descriptions and illustrations of Popov's two Siberian species leave much to be desired, I believe they are conspecific with the Idaho forms.

This species is quite similar in its basic conch shape to *D. demokidovi* Popov, but that species apparently is smooth, lacking any form of constrictions.

Occurrence. The middle shale member of the Thaynes Formation, *Columbites* fauna, Paris Canyon, Montpelier Canyon, Hot Springs, and Draney Creek, southeastern Idaho. The two species recorded by Popov are from the *Dieneroceras* Zone of Popov in three different localities in the Kolyma River basin, Siberia.

Repository. Holotype USNM 74989a (Pl. 53, figs. 10, 11); paratypes USNM 74989b (Pl. 53, fig. 12), USNM 74989c (Smith, 1932: pl. 48, figs. 5-7), USNM 74989d (Smith, 1932: pl. 48, figs. 8-10); suture specimens MCZ 9524 (Fig. 5A), MCZ 9525 (Fig. 5B), MCZ 9526 (Fig. 5C), MCZ 9527

(Fig. 5F), MCZ 9528 (Fig. 5G), MCZ 9529 (Fig. 5K); unfigured specimens from Montpelier Canyon MCZ 9530, from Hot Springs MCZ 9531. Holotype *Celtites planovolvis*, USNM 74988a (Pl. 53, figs. 7, 8); paratype USNM 74988b (Pl. 53, fig. 9); suture specimens USNM 74988c (Smith, 1932: pl. 48, fig. 16), USNM 74988d (Smith, 1932: pl. 48, figs. 17–20). Holotype *Celtites ursensis*, USNM 74987a (Pl. 53, figs. 1, 2); paratypes USNM 74987b (Pl. 53, figs. 3, 4), USNM 74987c (Pl. 53, figs. 5, 6), USNM 74987d (Smith, 1932: pl. 47, figs. 18–20), USNM 74987e (Smith, 1932: pl. 47, figs. 21–23).

Genus *Subvishnuites* Spath, 1930

Type species, *Subvishnuites welteri* Spath, 1930 (= *Vishnuites* sp. Welter, 1922)

Records on this genus have increased considerably in recent years. The type species of *Subvishnuites* was based on a single specimen from the *Owenites* fauna of Timor. Conspecific forms have been described by Kummel (1959: 443) from an *Owenites* fauna of South Island, New Zealand, by Popov (1962b: 43—as *Parinyoites mastykensis*) from an *Owenites* fauna of the Caucasus Mountains, and from an *Owenites* fauna of Afghanistan (Kummel and Erben, 1968). In addition, the *Owenites* Zone of Kwangsi, China, contains *Subvishnuites tientungensis* Chao (1959). The specimen from the *Dieneroceras* Zone of Siberia (Popov 1962a) described as *Inyoites eiekitensis* is a species of this genus. The *Columbites* Zone of southeast Idaho has yielded one fragmentary specimen that is described here. This specimen is quite like the Siberian *S. eiekitensis*. Finally, the Narmia Member of the Mianwali Formation in the Trans-Indus Surghar Range, West Pakistan, has yielded fragmentary representatives of this genus described as *S.* sp. indet. (Kummel, 1966). This horizon contains *Procamites kokeni*, *Prohungarites* cf. *crasseplicatus*, etc., and is late Scythian in age. *Xenaspis enveris* Arthaber (1911) from the *Subcolumbites* fauna of Albania

is considered here to be a species of *Subvishnuites*. The *Subcolumbites* fauna at Kotal-e-Tera, Afghanistan, has also yielded a couple of small specimens that have been recorded as *Subvishnuites* sp. indet. (Kummel, 1968a). There is also an interesting allied species described as *Subvishnuites* cf. *enveris* (Kummel, 1968b) from the *Subcolumbites* fauna of Kotal-e-Tera, Afghanistan.

This genus thus ranges in age through the whole of the upper half of the Scythian. As yet few specimens have been recovered and few species described.

Subvishnuites enveris (Arthaber)

Text-figure 4

Xenaspis enveris Arthaber, 1911: 230, pl. 20(4), fig. 3; Diener, 1915: 311; Spath, 1934: 293.

The type and only specimen of this species is not in the collection of the Paleontological Institute, Vienna. The relationships of this species and its assignment to *Subvishnuites* are discussed fully below in the description of *Subvishnuites* cf. *enveris* from Afghanistan. Spath (1934: 293) considered this species to have a relationship to *Eophyllites*, but this I find difficult to understand.

Occurrence. *Subcolumbites* fauna, Këira, Albania.

Repository. The specimen is apparently lost, as it is not in the Paleontological Institute, Vienna.

Subvishnuites cf. *enveris* (Arthaber)

Subvishnuites cf. *enveris* (Arthaber), Kummel, 1968b: 491, pl. 1, figs. 8, 9.

This is a most interesting specimen from a *Subcolumbites* fauna at Kotal-e-Tera, Afghanistan. The specimen measures 45 mm in diameter, approximately 20 mm for the width of the adoral whorl, 21 mm for the height, and 11.7 mm for the width of the umbilicus. The whorl sides are broadly arched, converging on to a rounded venter. The whorl sides bear widely spaced radial ribs that commence and are most conspicuous on the umbilical shoulder and decrease in intensity toward the venter

which is smooth. The adoral half volution has four such ribs. The ribs are also present on the inner whorls as far as they are preserved. The umbilical shoulder is abruptly rounded and the umbilical wall, nearly vertical. The suture is not preserved.

Arthaber's specimen of *Xenaspis enveris* is slightly more evolute than my Afghan specimen (34 percent versus 27 percent) and has an acute venter on the adoral part of the living chamber. The ribbing, according to Arthaber, is developed only on the living chamber. The absence of the ribs on the phragmocone could well be a matter of preparation or preservation. The suture of the Albanian specimen consists of two denticulated lateral lobes (Arthaber, 1911: pl. 20(4), fig. 3c).

It appears quite probable that the Albanian *Xenaspis enveris* is not conspecific with this Afghan specimen, though they are most probably congeneric. However, the assignment of these two specimens may be open to question. The type specimen of *Subvishnuites* is a smooth form with an acute venter as are all the other specimens assigned to this genus. The Albanian and Afghan specimens have prominent radial ribs. A case could be made that the Albanian and Afghan species are generically distinct from the more typical species of *Subvishnuites*. However, data are so incomplete on both the Albanian and Afghan species that it would be imprudent to establish a new genus with either of these specimens as type. Because of these factors, and because there are no other late Scythian genera to which these specimens have any similarity, it seems best to assign them to *Subvishnuites*.

Occurrence. *Subcolumbites* fauna, Kotal-c-Tera, Afghanistan.

Repository. MCZ 10148.

Subvishnuites eiekitensis (Popov)

Inyoites eiekitensis Popov, 1962a: 184, pl. 3, fig. 5, text-fig. 6.

The description and illustration of this

species leave much to be desired; even so, the whole appearance of the conch and the plan of the suture show this species to be a member of *Subvishnuites*. This species is very similar in general appearance to *Subvishnuites* sp. indet. from the *Columbites* Zone of southeast Idaho. However, that species is known only from a single fragmentary specimen, and data are insufficient to evaluate the relationships of the two forms.

Occurrence. *Dieneroceras* Zone of Popov (1961, 1962a), Lena and Olenek river basins, Siberia.

Subvishnuites sp. indet.

Plate 53, figure 15

A single fragmentary specimen of approximately 34 mm in diameter. The whorls are compressed, convex, converging on an acute venter. The lateral areas bear weak, broad, radial folds which are more apparent on the cast than they are on the shell. The umbilical shoulders are broadly rounded. The suture is only vaguely visible but it does show two lateral lobes.

This specimen is very similar in its form, etc., to *S. eiekitensis* (Popov) from the *Dieneroceras* Zone of Siberia. It could well be conspecific with that species but data are not sufficient to allow a detailed analysis.

Occurrence. *Columbites* Zone, Thaynes Formation, Montpelier Canyon, southeast Idaho.

Repository. MCZ 9512.

Genus *Hemilecanites* Spath, 1934

Type species, *Lecanites discus* Arthaber, 1908

Hemilecanites discus (Arthaber)

Plate 25, figures 9, 10; Text-figure 4

Lecanites discus Arthaber, 1908: 268, pl. 11(1), figs. 5a-c; Arthaber, 1911: 181, 238; Renz and Renz, 1947: 61; Renz and Renz, 1948: 55.

Proavites discus,—Diener, 1915: 228.

Hemilecanites discus,—Spath, 1934: 135, pl. 13, figs. 7a-d; Kummel, in Arkell et al., 1957: 1136, figs. 169, 3; Chao, 1959: 41, 196, pl. 3, figs. 1, 2.

Celtites kcirensis.—Renz and Renz (non Arthaber), 1948: 42, pl. 3, fig. 3 (non fig. 6).

This is another very distinctive species first described from the *Subcolumbites* fauna of Albania. Unfortunately, none of Arthaber's types are preserved in the Paleontological Institute, Vienna. The specimen recorded by Renz and Renz (1948: 55) is illustrated here on Plate 25, figures 9, 10. The inner whorls of this specimen, up to a diameter of 14 mm, are exposed, and these show the whorl section to be approximately as wide as it is high and the venter to be broadly rounded. It is in the following volutions that the whorls become compressed and the venter acute. The suture is nearly identical to that of Arthaber's holotype (Fig. 4E). Another representative of this species in the Chios fauna is one of the specimens Renz and Renz (1948: 42, pl. 3, fig. 3) assigned to *Celtites kcirensis*.

The specimen recorded by Chao (1959) yielded no suture, but the distinctive morphology of this species suggests that the specimen from Kwangsi, China, is conspecific with the Albanian and Chios specimens of *H. discus*.

The only other species of *Hemilecanites* is *H. paradiscus* n. sp. from the *Subcolumbites* fauna of the Tobin Formation, Nevada. This new species is quite similar to *H. discus*, but it is a more compressed and involute form with commensurate changes in the localization of the sutural elements (Fig. 4F).

Occurrence. *Subcolumbites* fauna of Albania, Chios, and Kwangsi, China (Chao collection 610).

Repository. The holotype is supposed to be in the Paleontological Institute, Vienna, but has not been located and is presumed lost; however, four topotype specimens are in the British Museum (Natural History), C22875–8. The plesiotype (Pl. 25, figs., 9, 10) from Chios is NHMB J13703; the plesiotype of *Celtites kcirensis*.—Renz and Renz (non Arthaber) 1948: pl. 3, fig. 3, is NHMB J13653.

Hemilecanites paradiscus n. sp.

Plate 29, figures 11, 12; Plate 31, figures 15, 16; Plate 35, figure 12; Text-figure 4

There are nine, mostly incomplete, specimens in the collection from the Tobin Formation, only two of which are complete enough to yield the following measurements:

	D	W	H	U	W/D	H/D	U/D
Holotype (MCZ 9465)	21.1	3.4	8.0	6.8	16.2	37.9	32.2
Paratype (MCZ 9451)	15.8	3.2	6.7	4.8	20.2	42.4	30.3

The conch is much compressed, lenticular in cross section. The venter is narrowly rounded to oxynote. The flanks are only slightly convex and the umbilical shoulder and wall very low. The shell is perfectly smooth except for extremely fine radial growth lines. None of the specimens are sufficiently complete to show the apertural regions. The sutures are shown on Figure 4F, G.

There is no question but this species is closely related to *H. discus*. It differs in its greater compression and involution and in the spacing of the sutural elements.

Occurrence. Tobin Formation, Pershing County, Nevada; south tip of Tobin Range, Cain Mountain 1:62,500 quad., center NW ¼ sec. 9, T. 26N, R. 39E, 5,500 ft. S., 27.5 ft. W from elevation point 5088 on range crest.

Repository. Holotype MCZ 9465 (Pl. 31, figs. 15, 16); paratype MCZ 9451 (Pl. 29, figs. 11, 12), MCZ 9473 (Pl. 35, fig. 12); suture specimens MCZ 9631, 9483; unfigured paratypes MCZ 9483.

Superfamily NORITACEAE Karpinsky, 1889

Family XENOCELITIDAE Spath, 1930

Genus *Xenoceltites* Spath, 1930

Type species, *Xenoceltites subevolutus* Spath, 1930

The genus *Xenoceltites* is very widely distributed in the mid-Scythian *Owenites* Zone where it is represented by a fairly

large number of species. In the overlying *Columbites* Zone the genus is represented by a single species (*X. spencei*) known only from southeast Idaho. In the late Scythian *Prohungarites* Zone there are only three species, one each from the Salt Range, China, and Primorye Region. In each case these species are represented by very few specimens. An indeterminate species of this genus has been recorded from the *Subcolumbites* fauna at Kotal-e-Tera, Afghanistan (Kummel, 1968b).

Xenoceltites sinuatus (Waagen)

Dinarites sinuatus Waagen, 1895: 33, pl. 10, fig. 4; Diener, 1915: 122.

Xenoceltites sinuatus Chao, 1959: 194; Kummel, 1966: 389, pl. 1, figs. 1-8.

Lecanites laqueus Waagen, 1895: 285, pl. 38, figs. 9, 10.

Xenodiscus laqueus Diener, 1915: 313.

This species has been recently described and illustrated (Kummel, 1966: 389) on the basis of new specimens. Among the few upper Scythian species of *Xenoceltites* known, this species is most similar to *X. crenoventrosus* Chao (1959) from Kwangsi, China. There is close agreement on the suture and general conch shape, but the pattern of ornamentation is different.

Occurrence. Sandstone beds of Narmia Member of Mianwali Formation, just above hard Bivalve Limestone, Chhidru Nala, Salt Range, West Pakistan.

Repository. Holotype GSI 7110; topotypes MCZ 9581, 9582.

Xenoceltites crenoventrosus Chao

Xenoceltites crenoventrosus Chao, 1959: 38, 194, pl. 3, figs. 14-15, pl. 42, figs. 2-6, text-fig. 8a-c.

The description and illustration of this species are inadequate. The conch is of the general form of *X. sinuatus*, but the ribs cross the venter forming a distinctive crenulated pattern. The suture is quite like that of *X. sinuatus*.

Occurrence. *Subcolumbites* fauna, Kwangsi, China (Chao collection 542b).

Xenoceltites spitsbergensis Spath

Xenoceltites spitsbergensis Spath, 1934: 128, pl. 9, figs. 1, 2, pl. 11, figs. 5, 7, 8; Kiparisova, 1961: 50, pl. 9, figs. 7, 8.

This species is recognized on the basis of two very small specimens of 21 and 15 mm in diameter. Even so, the similarity to the Spitsbergen xenoceltitids is quite striking, and I can do no more than agree with Kiparisova's determination. The type specimens of this species, from Spitsbergen, are of mid-Scythian *Owenites* Zone age and this specimen is said to have come from strata with *Subcolumbites*.

Occurrence. *Subcolumbites* fauna, Primorye Region, Siberia.

Xenoceltites spencei (Hyatt and Smith)

Plate 48, figures 5-9; Plate 52, figures 1-7; Text-figures 7, 8

Ophiceras spencei Hyatt and Smith, 1905: 119, pl. 62, figs. 1-10; Diener, 1915: 212; Smith, 1932: 50, pl. 62, figs. 1-10.

The middle shale member of the Thaynes Formation around Bear Lake, southeast Idaho, that contains the *Columbites* fauna has yielded an abundance of specimens of this species. Measurements of 99 specimens are given in Table 25 and the variations in whorl width and height are plotted on Figure 8. The forward projecting constrictions that cross the venter are quite variable in their intensity. As noted by Smith (1932: 50) these constrictions are most noticeable on the east; in many of the specimens they are not at all apparent or expressed on the shell. The suture consists of two denticulated lateral lobes and is quite variable in details of the basic pattern (Fig. 7).

This species is not really comparable or very close to any of the upper Scythian species assigned to *Xenoceltites*, as *sinuatus*, *crenoventrosus*, or the species assigned by Kiparisova (1961) to *X. spitsbergensis*. It is however, quite similar in its over-all aspect to the Spitsbergen forms Spath (1934) assigned to *X. subevolutus*, *X. gre-*

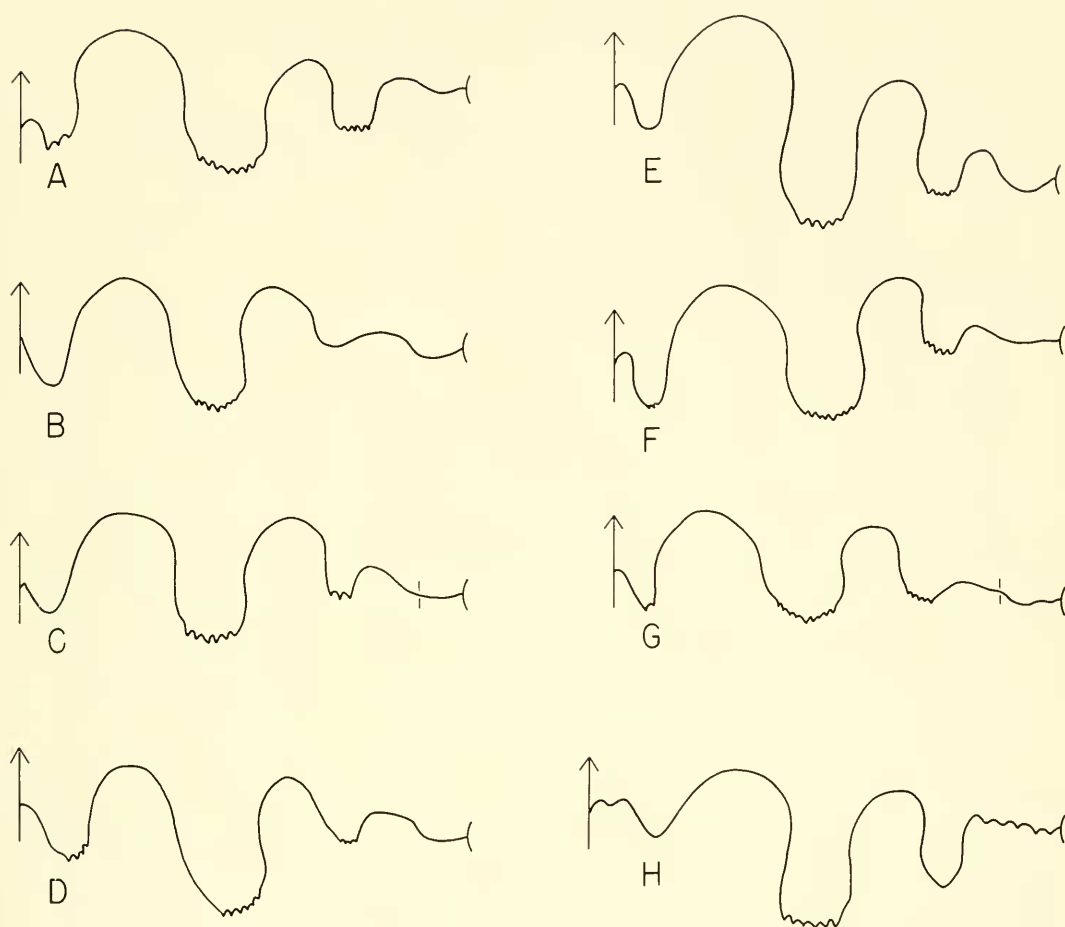


Figure 7. Diagrammatic representation of the sutures of *Xenoceltites spencei* (Hyatt and Smith), from the *Columbites* fauna, Thaynes Formation of southeastern Idaho. A, at a diameter of 17 mm (MCZ 9558); B, at a diameter of 21 mm (MCZ 9559); C, at a diameter of 18 mm (MCZ 9560); D, at a diameter of 22 mm (MCZ 9561); E, at a diameter of 13 mm (MCZ 9562); F, at a diameter of 24 mm (MCZ 9563); G, at a diameter of 34 mm (MCZ 9551, Pl. 52, fig. 1); H, paralectotype (Hyatt and Smith, 1905: pl. 62, figs. 5–7; Pl. 48, figs. 5, 6 of this report), at a diameter of 28 mm (USNM 75291b).

Specimens of figures A, C, D, from Hot Springs, B, E, F, G from Montpelier Canyon, H, from Paris Canyon.

goryi, or *X. spitsbergensis*, all of mid-Scythian, *Owenites* Zone, age.

Occurrence. Middle shale member of Thaynes Formation, *Columbites* Zone, at Paris Canyon, Montpelier Canyon, and Hot Springs, Bear Lake region, and Draney Creek, southeast Idaho.

Repository. Lectotype (Pl. 48, figs. 7–9) USNM 75291a; paralectotype (Pl. 48, figs. 5, 6) USNM 75291b, paralectotype (Hyatt

and Smith, 1905: pl. 62, figs. 8–10) USNM 75291c; plesiotypes (Pl. 52, fig. 1) MCZ 9551, (Pl. 52, fig. 2) MCZ 9552, (Pl. 52, fig. 3) MCZ 9553, (Pl. 52, fig. 4) MCZ 9554, (Pl. 52, fig. 5) MCZ 9555, (Pl. 52, fig. 6) MCZ 9556, (Pl. 52, fig. 7) MCZ 9557; suture specimens Figure 7, MCZ 9551, 9558–9563; specimens from Montpelier Canyon MCZ 9630, from Hot Springs MCZ 9629.

TABLE 25. MEASUREMENTS OF *XENOCELITITES SPENCEI* (HYATT AND SMITH) FROM THE *COLUMBITES* FAUNA, BEAR LAKE REGION, SOUTHEASTERN IDAHO.

	D	W	H	U	W/D	H/D	U/D		D	W	H	U	W/D	H/D	U/D
1.	51.5	?	16.2	19.8	?	31.5	38.4	47.	20.1	5.8	7.8	6.6	28.9	38.8	32.8
2.	49.8	10.5	14.5	21.8	21.1	29.1	43.8	48.	20.0	5.2	7.6	6.4	26.0	38.0	32.0
3.	46.4	11.0	16.2	19.2	23.7	34.9	41.4	49.	20.0	5.3	8.2	6.6	26.5	41.0	33.0
4.	45.8	11.4	17.4	16.1	24.9	37.9	35.2	50.	20.0	6.3	8.0	6.7	31.5	40.0	33.5
5.	42.3	9.4	15.0	16.3	22.2	35.5	38.5	51.	19.8	5.6	8.2	6.3	28.3	41.4	31.8
6.	42.3	10.5?	13.8	18.6	24.8?	32.6	43.9	52.	19.8	5.5	7.8	6.9	27.8	39.4	34.8
7.	40.8	10.9	15.7	13.4	26.7	38.5	32.8	53.	19.7	5.8	7.3	7.0	29.4	37.1	35.5
8.	40.7	10.0	14.4	15.2	24.6	35.4	37.3	54.	19.7	6.0	8.5	5.7	30.5	43.1	28.9
9.	40.0	10.0	16.0	12.2	25.0	40.0	30.5	55.	19.7	6.6	7.2	6.1	33.5	36.5	30.9
10.	39.4	9.4	12.7	17.3	23.9	32.2	43.9	56.	19.5	6.0	8.3	5.9	30.8	42.6	30.3
11.	33.4	9.0	15.0	8.7	26.9	44.9	26.0	57.	19.5	5.7	8.2	5.7	29.2	42.1	29.2
12.	33.2	7.8	10.8	14.0	23.5	32.5	42.2	58.	19.2	6.2	8.0	5.9	32.2	41.7	30.7
13.	31.8	7.8	12.2	11.3	24.5	38.4	35.5	59.	19.1	6.0	8.7	5.2	31.4	45.5	27.2
14.	31.7	8.2	12.3	10.3	25.9	38.8	32.5	60.	19.0	6.0	7.2	6.5	31.6	37.9	34.2
15.	30.6	8.1	10.6	12.6	26.5	34.6	41.2	61.	19.0	6.0	7.3	6.4	31.6	38.4?	33.7
16.	30.5	6.6	10.2	12.6	21.6	33.4	41.3	62.	19.0	6.2	8.0	5.6	32.6	42.1	29.5
17.	29.7	8.3	13.1	7.7	27.9	44.1	25.9	63.	18.8	5.6	7.7	6.0	29.8	40.9	31.9
18.	29.2	7.5	10.7	10.8	25.7	36.6	36.9	64.	18.4	5.6	7.1	6.6	30.4	38.9	35.9
19.	29.0	7.4	11.4	9.7	25.5	39.3	33.4	65.	18.2	5.7	7.0	6.3	31.3	38.5	34.6
20.	28.8	7.6	10.2	11.0	26.4	35.4	38.2	66.	18.0	4.6	7.1	6.5	25.6	39.4	36.1
21.	26.7	7.5	9.8	10.0	28.1	36.7	37.5	67.	17.8	5.8	7.3	5.7	32.6	41.0	32.0
22.	26.5	7.1	10.2	9.3	26.8	38.5	35.1	68.	17.8	5.5	7.1	6.1	30.9	39.9	34.3
23.	25.4	7.2	9.0	9.4	28.3	35.4	37.0	69.	17.5	5.3	6.6	6.4	30.3	37.7	36.6
24.	25.3	6.8	6.8	9.6	26.9	26.9	37.9	70.	17.5	5.8	6.3	6.8	33.1	36.0	38.9
25.	25.3	6.9	10.6	8.3	27.3	41.9	32.8	71.	17.5	5.7	7.2	5.4	32.6	41.1	30.9
26.	25.3	7.3	9.7	9.3	28.9	38.3	36.8	72.	17.5	5.2	6.1	6.7	29.7	34.9	38.3
27.	24.6	6.4	9.4	8.7	26.0	38.2	35.4	73.	17.4	4.8	7.2	6.1	27.6	41.4	35.1
28.	24.3	6.8	9.1	9.8	27.9	37.4	40.3	74.	17.3	5.4	7.4	5.3	31.2	42.8	30.6
29.	24.0	6.8	10.2	7.0	28.3	42.5	29.2	75.	17.2	5.5	7.0	5.6	31.9	40.7	32.6
30.	23.5	?	10.0	7.0	?	42.6	29.8	76.	17.1	5.0	6.5	5.3	29.2	38.0	30.9
31.	23.5	6.7	8.3	9.3	28.5	35.3	39.6	77.	17.0	6.0	6.8	5.1	35.3	40.0	30.0
32.	23.3	6.5	9.4	7.4	27.9	40.3	31.8	78.	16.9	5.3	6.7	6.1	31.4	39.6	36.1
33.	23.3	6.5	9.3	8.0	27.9	39.9	34.3	79.	16.8	5.5	6.5	6.0	32.7	38.7	35.7
34.	23.3	6.4	9.6	7.8	27.5	41.2	33.5	80.	16.6	5.2	5.6	7.1	31.3	33.7	42.8
35.	23.2	6.2	9.0	6.2	26.7	38.8	26.7	81.	16.5	5.1	6.2	5.8	30.9	37.6	35.2
36.	23.0	6.4	8.7	8.2	27.8	37.8	35.7	82.	16.3	5.3	6.3	5.3	32.5	38.7	32.5
37.	23.0	6.3	9.1	7.2	27.4	39.6	31.3	83.	15.9	5.2	6.7	5.0	32.7	42.1	31.4
38.	21.7	?	9.0	6.9	?	41.5	31.8	84.	15.6	5.2	6.7	4.8	33.3	42.9	30.8
39.	21.7	6.2	8.3	8.2	28.6	38.2	37.8	85.	15.2	5.1	6.2	4.6	33.6	40.8	30.3
40.	21.5	7.5	9.4	6.6				86.	15.0	5.3	6.1	5.0	35.3	40.7	33.3
41.	21.3	6.6	9.0	7.1	30.9	42.3	33.3	87.	15.0	5.2	5.7	5.7	34.7	38.0	38.0
42.	21.1	6.3	8.1	7.6	29.9	38.4	36.0	88.	14.8	5.1	5.9	5.1	34.5	39.9	34.5
43.	21.0	6.3	9.7	5.0	30.0	46.2	23.8	89.	14.7	4.7	5.7	5.5	31.9	38.8	37.4
44.	20.8	5.2	8.7	6.4	25.0	41.8	30.8	90.	14.6	4.5	6.1	5.0	30.8	41.8	34.2
45.	20.7	6.0	9.4	6.1	28.9	45.4	29.5	91.	14.6	5.2	5.6	4.8	35.6	38.4	32.9
46.	20.6	5.4	8.4	6.8	26.2	40.7	33.0	92.	14.4	4.9	5.8	4.4	34.0	40.3	30.6

4. Plesiotype, MCZ 9551 (Pl. 52, fig. 1).

7. Paralectotype, USNM 75291b (Pl. 48, figs. 5, 6).

9. Lectotype, USNM 75291a (Pl. 48, figs. 7-9).

15. Plesiotype, MCZ 9556 (Pl. 52, fig. 6).

21. Plesiotype, MCZ 9554 (Pl. 52, fig. 4).

23. Plesiotype, MCZ 9552 (Pl. 52, fig. 2).

24. Suture specimen, MCZ 9563 (Fig. 7F).

36. Suture specimen, MCZ 9561 (Fig. 7D).

59. Suture specimen, MCZ 9560 (Fig. 7C).

76. Plesiotype, MCZ 9555 (Pl. 52, fig. 5).

TABLE 25. *Continued*

	D	W	H	U	W/D	H/D	U/D		D	W	H	U	W/D	H/D	U/D
93.	14.2	4.8	4.8	5.3	33.8	33.8	37.3	97.	12.2	4.1	4.2	4.0 ²	33.6	34.4	32.8 ²
94.	14.0	4.9	5.1	5.4	35.0	36.4	38.6	98.	11.0	4.0	4.2	3.9	36.4	38.2	28.0
95.	13.6	4.9	5.2	4.8	36.0	38.2	35.3	99.	8.3	3.1	2.8	3.2	37.3	33.7	38.6
96.	13.4	4.5	5.1	4.8	33.6	38.1	35.8								

96. Suture specimen, MCZ 9562 (Fig. 7E).

98. Plesiotype, MCZ 9557 (Pl. 52, fig. 7).

Genus *Preflorianites* Spath, 1930**Type species, *Danubites strongi* Hyatt and Smith, 1905**

Evolute forms with arched venters, often tending to become acute; with radial ribbing, most pronounced on inner lateral areas near umbilical shoulders and not crossing the venter; suture with two lateral lobes.

Preflorianites is quite a generalized ammonite. This, accompanied by the fact that it is not particularly abundant in the upper half of the Scythian, has made analysis of the species described to date very difficult. The late Scythian species of *Preflorianites* recognized here are:

Preflorianites sulioticus (Arthaber)*Preflorianites garbinus* (Renz and Renz)*Preflorianites multiplicatus* (Mojsisovics)*Preflorianites intermedius* Tozer

In addition, the *Columbites* fauna of southeast Idaho has yielded one species, *P. montpelierensis*.

I am not at all certain as to the merits of all these species. Each is known from only one or very few specimens; thus little or no data are available on the range of variation in rib patterns, degree of involutions, shape of whorl sections, suture, etc. Few meaningful comparisons can be made between one species group and the others.

The late Scythian species are known from the *Subcolumbites* fauna of Albania (*sulioticus*), the *Subcolumbites* fauna of Chios (*sulioticus*, *garbinus*), the *Olenekites* fauna of the Olenek River region (*multiplicatus*), from a late Scythian fauna of British Columbia (*intermedius*), and from the *Co-*

lumbites fauna of southeast Idaho (*montpelierensis*).

Preflorianites sulioticus* (Arthaber)*Plate 4, figures 5, 6; Plate 19, figures 1, 2, 5–8; Text-figure 9**

Xenodiscus sulioticus Arthaber, 1911: 229, pl. 19(3), figs. 6a, b, pl. 20(4), figs. 2a, b; Diener, 1915: 315; C. Renz, 1928: 155; Renz and Renz, 1947: 61; Renz and Renz, 1948: 56, pl. 3, figs. 1, 2.

Preflorianites sulioticus,—Spath, 1934: 133, pl. 12, figs. 2a–d.

Ophiceras cfr. *Nangaensis* Arthaber (1911: 239, pl. 21(5), fig. 5) non Waagen.

Xenodiscus sp. ind. aff. *Nangacensis*,—Diener, 1915: 313.

Arthaber (1911: 230) states he had four specimens of this species; only the two specimens he illustrated are still preserved. It is of interest that whereas Arthaber had only four specimens for study, the British Museum (Natural History) has fifteen topotypes obtained by purchase. The description of the species by Arthaber (1911) and the comments by Spath (1934: 133) are adequate for the two syntypes even though the specimens are poorly preserved. The specimens of this species figured by Renz and Renz (1948, pl. 3, figs. 1, 2) are very typical forms. They clearly show that the adoral decrease in ribbing intensity is highly variable, taking place at different growth stages.

The two specimens which Arthaber (1911) assigned to *Ophiceras* cfr. *nangaensis* are both poorly preserved and owe many of their morphological features to excessive grinding and polishing. One of the specimens (Pl. 19, figs. 1, 2) shows indications

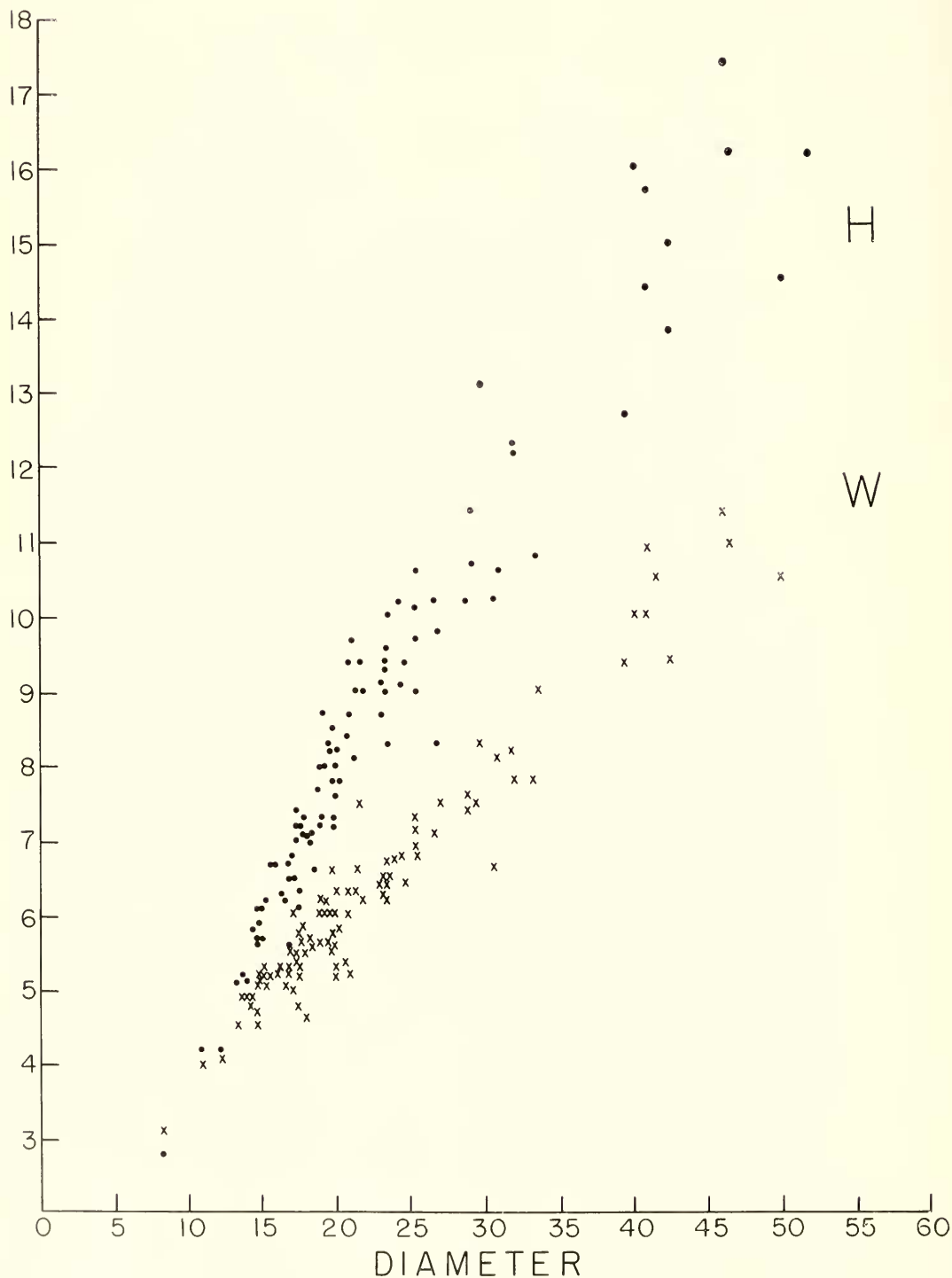


Figure 8. Variation in whorl height (H) and whorl width (W) of *Xenaceltites spencei* (Hyatt and Smith) from *Calumbites* fauna, Bear Lake region, southeast Idaho. The data on this graph are from Table 25.

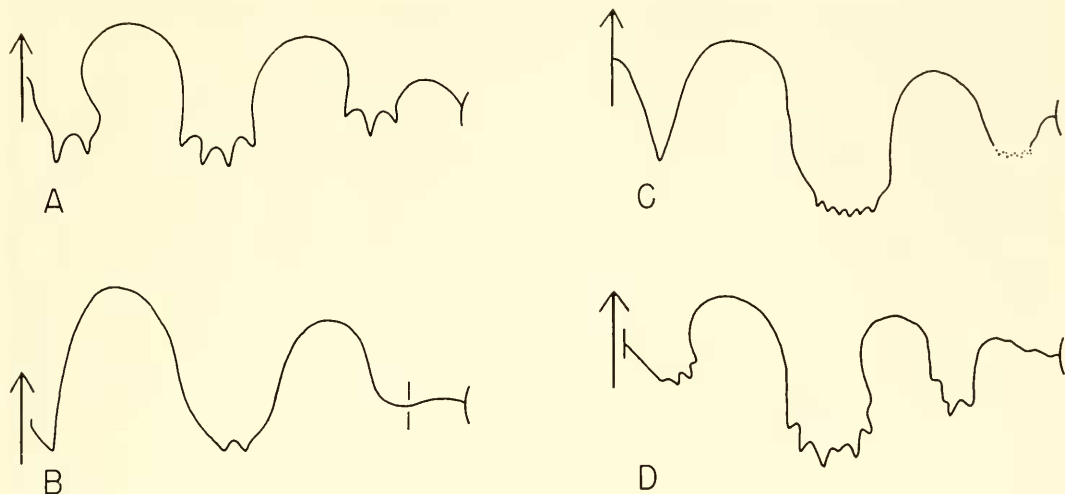


Figure 9. Diagrammatic representation of the suture of: A, *Preflorianites sulioticus* (Arthaber, 1911: pl. 20(4), fig. 2b), from *Subcolumbites* fauna of Albania, at a diameter of approximately 20 mm; B, *Preflorianites garbinus* (Renz and Renz), from *Subcolumbites* fauna of Chios (NHMB J13696), at a diameter of 25 mm; C, *Preflorianites mantelienensis* n. sp., from *Columbites* fauna, southeast Idaho (MCZ 9498), at a whorl height of 5 mm; D, *Preflorianites strongi* (Hyatt and Smith, 1905: pl. 9, fig. 6), from *Meekoceras* fauna, Inyo Range, California, at a diameter of approximately 30 mm.

of ribs on the umbilical shoulder; the ribbing has been completely ground away on the flanks. Both these specimens I believe are representatives of *P. sulioticus*. A suture of *Preflorianites sulioticus* is illustrated on Figure 9A.

Occurrence. *Subcolumbites* fauna of Albania and Chios.

Repository. The two syntypes from Albania and the two specimens of *Ophiceras* cf. *nangaensis* are in the Paleontological Institute, Vienna. The specimens from Chios are NHMB J13704 (Renz and Renz, 1948, pl. 3, fig. 1), NHMB J13705 (Renz and Renz, 1948, pl. 3, fig. 2); unfigured specimens from Maradovuno NHMB J13706.

Preflorianites garbinus (Renz and Renz)

Plate 20, figures 10, 11; Text-figure 9

Inyoites n. sp. C. Renz, 1947: 176.

Inyoites garbinus Renz and Renz, 1947: 60, 76;

Renz and Renz, 1948: 53, pl. 12, figs. 10–10b.

The single specimen in the Chios fauna studied by the Renzes for which they introduced this new species name is indeed

superficially similar to *Inyoites*. However, the venter is acute but does not bear a keel as in the typical *Inyoites* from the *Meekoceras* fauna of western North America. Likewise, the typical *Inyoites* have a vertical umbilical wall whereas this Chios specimen has a rounded umbilical wall. The specimen is slightly weathered, and thus the fine denticulations of the suture are lost and the suture as drawn (Fig. 9B) is that of the weathered surface. A second specimen in the Chios collection but not mentioned by the Renzes is illustrated here on Plate 20, figures 10, 11. It is a slightly more inflated form than the holotype but even more preflorianitid in aspect.

It is for the above reasons that this species is believed to be a much compressed species of *Preflorianites*. The Chios fauna contains a very "typical" species of *Preflorianites*—*P. sulioticus* (Arthaber)—which has a much more inflated whorl section. Unfortunately, *P. sulioticus* is represented by only two specimens in the Chios fauna, and *P. garbinus* by only two specimens; thus the relationship between these two

species must remain uncertain until more material becomes available.

Occurrence. *Subcolumbites* fauna, Maradovuno, Chios.

Repository. Holotype NHMB J13696; paratype (Pl. 20, figs. 10, 11) NHMB J13697.

***Preflorianites multiplicatus* (Mojsisovics)**

Ceratites multiplicatus Mojsisovics, 1886: 25, pl. 9, figs. 15a, b.

Xenodiscus multiplicatus,—Diener, 1915: 313; Popov, 1961: 7.

"*Ceratites*" *multiplicatus*,—Spath, 1934: 128.

Xenoceltites multiplicatus,—Kummel, 1961: 521.

Ceratites fissiplicatus Mojsisovics, 1886: 26, pl. 9, figs. 18a, b, 19c.

Xenodiscus fissiplicatus,—Diener, 1915: 312; Popov, 1961: 7.

Ceratites discretus Mojsisovics, 1886: 27, pl. 9, figs. 20a–c.

Xenodiscus discretus,—Diener, 1915: 312; Popov, 1961: 7.

Xenoceltites discretus,—Kummel, 1961: 521.

Ceratites hyperboreus Mojsisovics, 1886: 26, pl. 9, figs. 16, 17.

Xenodiscus hyperboreus,—Diener, 1915: 313.

Xenoceltites hyperboreus,—Kummel, 1961: 521.

It is apparent from the five specimens illustrated by Mojsisovics (1886, pl. 9, figs. 15–20) and brought together here as representing a single species that there is considerable variability in the ribbing patterns. The Olenek fauna has recently been monographed by Popov (1961), but in this extensive revision none of these species are described or illustrated; they are merely mentioned in a summary list of species from the *Olenekites* Zone.

Occurrence. *Olenekites* Zone in region of Olenek River, northern Siberia.

***Preflorianites intermedius* Tozer**

Preflorianites intermedius Tozer, 1965a: 18, pl. 11, figs. 92–6, text-fig. 2.

This species is based on a single fragmentary specimen and in outward appearance is very much like nearly all other upper Scythian specimens of this genus. The smallness of all the samples, however, prevents any meaningful comparisons.

Occurrence. Toad Formation, Halfway River area, British Columbia, associated

with *Popovites occidentalis* and *Monacanthites monoceros*.

***Preflorianites montpelierensis* n. sp.**

Plate 43, figures 2, 3; Plate 44, figures 11–13; Text-figure 9

The *Columbites* fauna of southeastern Idaho has yielded thirteen specimens of this interesting species. The conch is evolute, compressed, and small. The inner volutions have whorls which are approximately as wide as high with rounded venters, and slightly convex lateral areas and rounded umbilical shoulders. The lateral areas bear radial ribs that are projected forward on the ventral shoulder. In general the venter is smooth, but occasionally there are constrictions crossing the venter, constrictions which are the continuation of rib interspaces on the lateral areas. The number and prominence of these constrictions are highly variable; the most pronounced development is in the specimen shown on Plate 43, figures 2, 3.

The length of the body chamber is not known for sure, but it is at least more than half a volution. The body chamber is much more compressed than the phragmocone and the venter becomes narrowly rounded, the lateral areas convergent. Likewise, the radial ribs become very subdued.

The suture is of a simple ceratite plan with two lateral lobes (Fig. 9C).

This species is not unduly different from the other upper Scythian species of *Preflorianites*. In its somewhat compressed whorls this species is especially like *P. garbinus* from the *Subcolumbites* fauna of Chios.

Occurrence. Middle shale member of Thaynes Formation, *Columbites* fauna at Montpelier Canyon and Hot Springs, south-east Idaho.

Repository. Holotype, MCZ 9494 (Pl. 44, fig. 13); figured paratypes MCZ 9495 (Pl. 43, figs. 2, 3), MCZ 9498 (Pl. 44, fig. 12), MCZ 9635 (Pl. 44, fig. 11); unfigured paratypes from Montpelier Canyon MCZ 9497, from Hot Springs MCZ 9496.

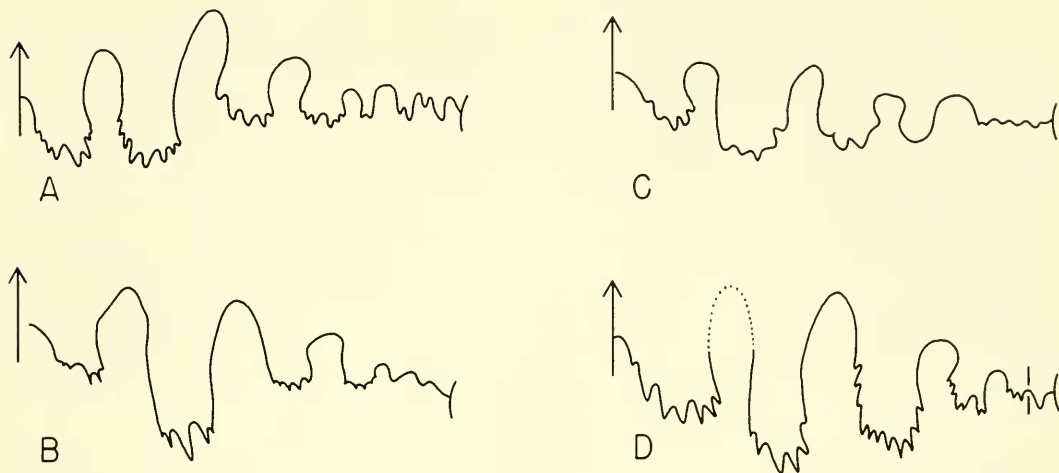


Figure 10. Diagrammatic representation of the suture of: A, holotype of *Pseudaspidites popovi* n. sp., from *Columbites* fauna of southeast Idaho, at a diameter of 48 mm (MCZ 9575); B, paratype *Pseudaspidites popovi* n. sp., from *Columbites* fauna of southeast Idaho, at a diameter of 28 mm (MCZ 9636); C, holotype *Pseudaspidites posterius* (Popov, 1961: fig. 9), from *Dieneroceras* Zone, northern Siberia; D, *Pseudaspidites yudishthira*,—Krafft and Diener (1909: pl. 15, fig. 5), from *Hedenstroemia* fauna of the Himalayas.

Family PARANORITIDAE Spath, 1930

Genus *Pseudaspidites* Spath, 1934

Type species, *Aspidites muthianus* Krafft and Diener, 1909

Pseudaspidites popovi n. sp.

Plate 44, figures 14, 15; Plate 55, figures 8, 9; Text-figure 10

This species is based on two specimens that are all phragmocone. The larger specimen and holotype has an approximate diameter of 63 mm, the width of the most adoral part of the last volution is 14.8 mm, the height is 34.7 mm, and the diameter of the umbilicus is 4.9 mm. The venter is narrowly rounded, the lateral areas broadly arched. The umbilical shoulders are sharply rounded. The lateral areas bear slightly sinuous, narrow, low ribs and fine growth lines. The suture is shown on Figure 10A. The smaller specimen measures 32.3 mm in diameter, 7.8 mm for the width of the adoral whorl, 17.4 mm for the height, and 4.5 mm for the diameter of the umbilicus. The suture is shown on Figure 10B.

The general configuration of the conch and the suture clearly allies this species

with *Pseudaspidites*. This genus is a fairly common member of the mid-Scythian *Owenites* Zone; species of it are known from the *Meekoceras* Zone of Idaho and Nevada (*P. wheeleri* Kummel and Steele, 1962: 673), from the *Hedenstroemia* fauna of the Himalayas (*P. muthianus* and *P. yudishthira*,—Krafft and Diener, 1909), and from mid-Scythian horizons in northern Siberia (*Clypeoceras gautmani* Popov, 1961: 49). The basic outline and elements of the suture are quite similar in all these species, but there is a particularly close similarity of the suture of this species to the suture of *P. yudishthira* Diener from the *Hedenstroemia* fauna of Muth, Himalayas (Fig. 10D).

The present species is from the *Columbites* Zone of southeastern Idaho and thus is younger than the species mentioned above. This, in fact, is the first recognition of a species of *Pseudaspidites* from a zone younger than that of *Meekoceras* (or *Owenites*).

The fauna of the *Dieneroceras* Zone of northern Siberia described by Popov (1961) I believe to be contemporaneous with that

of the *Columbites* fauna of southeastern Idaho. This Siberian fauna contains one species—*Koninckites posterius* Popov (1961: 51, pl. 4, fig. 2)—that is very similar to *Pseudaspidites popovi*. This species clearly belongs in *Pseudaspidites* and not in *Koninckites*. The principal differences between these species are in details of the suture (Fig. 10C).

Occurrence. Middle shale member of Thaynes Formation, *Columbites* Zone, Hot Springs, southeastern Idaho.

Repository. Holotype, MCZ 9575; paratype MCZ 9636.

Pseudaspidites posterius (Popov)

Text-figure 10

Koninckites posterius Popov, 1961: 51, pl. 4, fig. 2.

This species is remarkably similar in conch form to *P. popovi* described above. The sutures are likewise quite similar (Fig. 10); the differences center mainly in the length of the lobes and in the auxiliary series. Popov compared his species with *Koninckites septentrionalis* Diener (1895: pl. 1, figs. 1a–c) from the Primorye Region and *Meekoceras timorensis* Wanner (1911: 185, pl. 6, fig. 2, pl. 7, figs. 5, 6) from Timor. There is a superficial resemblance between these forms but both these species are approximately mid-Scythian in age, whereas *P. posterius* comes from a younger horizon contemporaneous with the *Columbites* fauna of Idaho.

Occurrence. *Dieneroceras* Zone of Popov (1961), delta of the Lena River, Siberia.

Family PROPTYCHITIDAE Waagen, 1895

Genus *Proptychitoides* Spath, 1930

Type species, *Proptychitoides decipiens* Spath, 1930

(= *Proptychites latifimbriatus* Arthaber, 1911, non de Koninck)

Some of the more conspicuous upper Scythian ammonites belong to this genus; they are likewise often some of the biggest forms in a fauna. Arthaber (1911) first

recognized the group in the *Subcolumbites* fauna from Albania. At that time he allied the group to the *Proptychites* described by Waagen (1895) from the Salt Range, noting, however, that his Albanian species differed from the Salt Range species in the more coarsely denticulated lobes and the club-shaped, asymmetrical saddles of the suture. Spath (1930: 30; 1934: 171) has correctly summarized the major aspects of these two species groups and introduced the genus *Proptychitoides* for the Albanian forms. This change has been widely accepted.

Since the first recognition of the group within the *Subcolumbites* fauna of Albania, it has been recorded from the same horizon in Kwangsi, China, and Timor. In addition, it was recorded from a horizon of uncertain position in the upper Scythian in northern Siberia. The previous studies of forms in these several faunas which I believe to belong in *Proptychitoides* have resulted in the introduction of 22 species names included within seven genera. Re-examination of all the available specimens from all but the fauna from Kwangsi, China, leads me to conclude that there are only five valid species of *Proptychitoides*. The species of *Proptychitoides* recognized as valid are:

Proptychitoides decipiens Spath
Proptychitoides trigonalis (Arthaber)
Proptychitoides arthaberi (Welter)
Proptychitoides tunglaensis Chao
Proptychitoides kummeli (Popov)

It is only in the *Subcolumbites* faunas of Albania and Chios that two species (*decipiens* and *trigonalis*) occur together. In all the other faunas mentioned above only a single species is present. The Albanian and Chios species differ in the degree of involution, degree of inflation of the whorls, and in ornamentation, but their sutures are essentially identical. *Proptychitoides decipiens* is the more involute, compressed species, and *P. trigonalis* is the more evolute form with a more inflated whorl. *Proptychitoides arthaberi* from Timor and *P.*

tunglanensis from Kwangsi, China, have the same general shell architecture as *P. decipiens*; unfortunately, the suture in both of these species is not as well known as would be desired. The suture of *P. arthaberi*, reproduced on Figure 11L, had, according to Welter (1922), less distinctly rounded saddles. Spath, however (1934: 177), on examination of one topotype specimen found this not to be the case. Due to poor preservation and incomplete data, it is not possible to make detailed comparisons with *P. tunglanensis*. Both these species could well be conspecific with *P. decipiens* from Albania and Chios; they are unfortunately known from so few specimens that a complete analysis of their characters is not yet possible.

There is one other Eurasian species of *Proptychitoides*, *P. kummeli* (Popov), from the Olenek River region of northern Siberia. This species has the general shell architecture of *P. trigonalis*, that is, somewhat evolute with an inflated whorl, and a suture very much like that given by Welter (1922) for *P. arthaberi* (Fig. 11K, L), and thus, is of the general plan of the Albanian and Chios species of *Proptychitoides*.

Proptychitoides decipiens Spath

Plate 8, figures 1–4; Plate 12, figure 3;
Text-figure 11

Proptychites latifimbriatus,—Arthaber (non de Koninck), 1911: 223, pl. 19(3), figs. 1, 2; Renz, 1928: 155.

Proptychites sp. ind. aff. *latifimbriatus*,—Arthaber (non de Koninck),—Diener, 1915: 231.

Proptychitoides decipiens Spath, 1930: 39; Spath, 1934: 171, figs. 51a, b; Kummel, in Arkell et al., 1957: L138, fig. 171, 6.

Proptychites krafftii Arthaber, 1911: 224, pl. 19(3), fig. 3; Diener, 1915: 231.

Proptychitoides krafftii,—Spath, 1934: 174, fig. 51c.

Meekoceras hakki Arthaber, 1911: 247, pl. 22(6), figs. 1, 2; Diener, 1915: 192.

Proptychitoides hakki,—Spath, 1934: 176, fig. 51e.

Proptychites balcanicus Renz and Renz, 1947: 61, 77; Renz and Renz, 1948: 66, pl. 5, figs. 9–9a.

Proptychites lawrencianus (de Koninck). mut. *postindica* Renz and Renz, 1947: 61, 77; Renz and Renz, 1948: 67, pl. 5, figs. 8–8a.

TABLE 26. MEASUREMENTS OF *PROPTYCHITOIDES DECIPIENS* SPATH FROM THE SUBCOLUMBITES FAUNAS OF ALBANIA AND CHIOS.

	D	W	H	U	W/D	H/D	U/D
1.	178.0	50.0	85.0	37.0	28.1	47.8	20.8
2.	153.0	45.00	75.00	35.0	29.4	49.0	22.9
3.	81.2	?	42.0	11.1	?	51.7	13.7
4.	79.0?	24.0	45.8	7.0	30.4?	57.9?	8.9?
5.	61.4	18.6?	33.1	7.7	30.3	53.9	12.5
6.	36.4	?	19.3	5.8	?	53.0	15.9

1. Syntype, *Meekoceras hakki* Arthaber (1911: pl. 22(6), fig. 1a–c), PIUV.
2. Syntype, *Meekoceras hakki* Arthaber (1911: pl. 22(6), fig. 2), PIUV.
3. Lectotype, *Proptychitoides decipiens* Spath [= *Proptychites latifimbriatus* (de Koninck)] Arthaber (1911: pl. 19 (3), figs. 2a–c), PIUV.
4. Holotype, *Proptychites krafftii* Arthaber (1911: pl. 19 (3), figs. 3a–c), PIUV.
5. Holotype, *Proptychites lawrencianus* (de Koninck) mut. *postindica* Renz and Renz (1948: pl. 5, fig. 8, NHMB J13725).
6. *Proptychites balcanicus* Renz and Renz (1948: pl. 5, fig. 9), NHMB J13721.

Much of the difficulty in the interpretation of the species of the genus *Proptychitoides* from Albania has been due to the generally poor preservation of the specimens. Features of surface ornamentation, the suture, and measurements of the standard conch dimensions are seldom clearly preserved. In addition, the described species are represented by one or very few specimens.

The type specimen of *P. decipiens* is refigured here on Plate 8, figures 3, 4. The second specimen of this species illustrated by Arthaber (1911: pl. 19(3), figs. 1a–c) is apparently lost. The independent status of this species and related forms from the Salt Range *Proptychites* is most apparent in the suture with its asymmetrical, phylloid saddles (Fig. 11G–J).

Proptychites krafftii (Arthaber, 1911: pl. 19(3), figs. 3a–c; Plate 8, figures 1, 2 of this report) is merely a slightly more involute member of *P. decipiens* (see Table 26). Arthaber had only three specimens of this species, of which only one is still preserved; there is in addition a single specimen in the British Museum of Natural

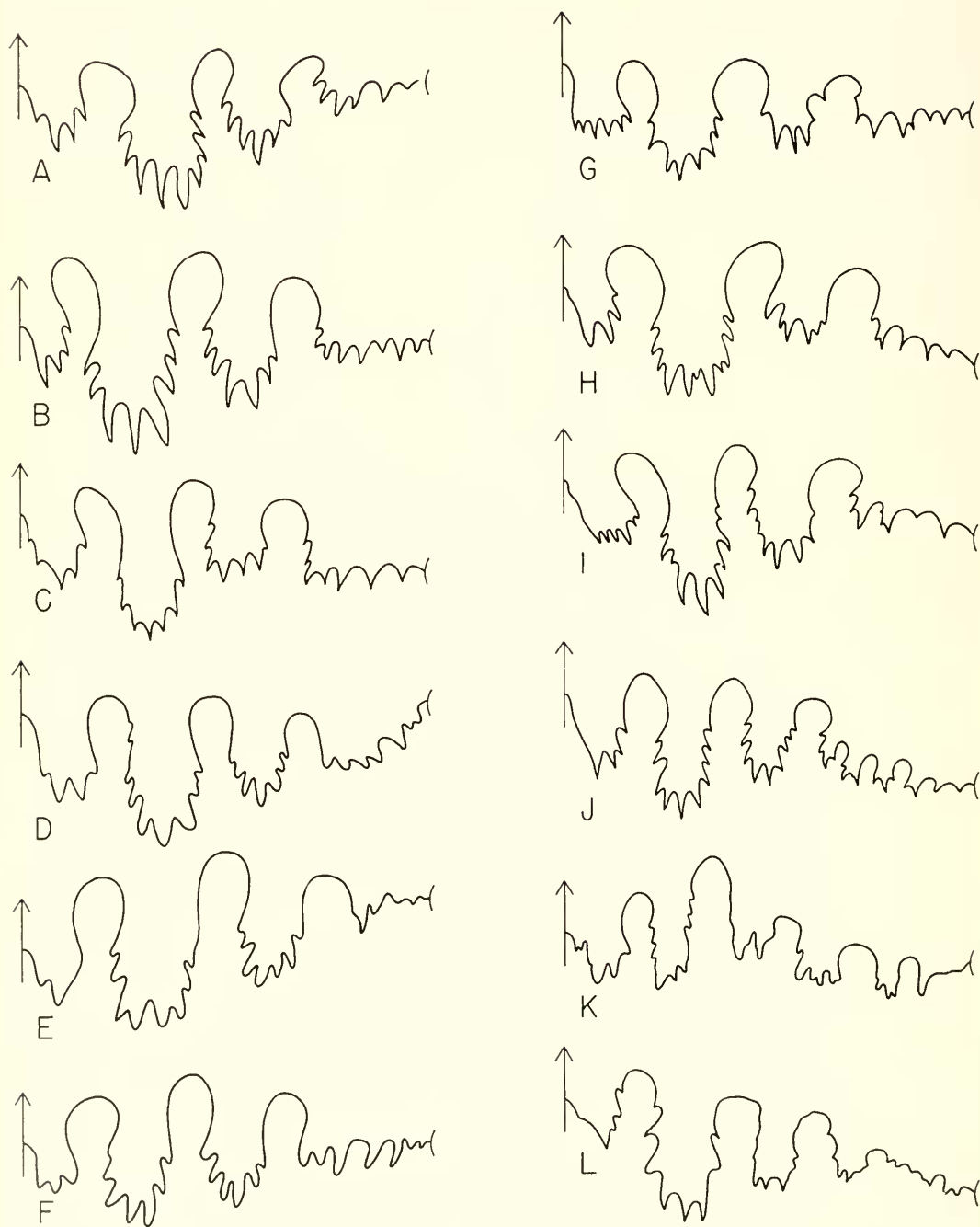


Figure 11. Diagrammatic representation of the sutures of: A–F, *Proptychitoides trigonalis* (Arthaber). A, holotype, at a diameter of 74 mm (Arthaber, 1911: pl. 19[3], fig. 4c; Pl. 9, figs. 3, 4 of this report); B, holotype of *Proptychites bertisci* Arthaber (1911: pl. 19[3], figs. 5a–c; Pl. 9, figs. 1, 2 of this report), at a diameter of 68 mm; C, holotype, *Meekoceras mahomedis* Arthaber (1911: pl. 22[6], figs. 3a–c; Pl. 10, figs. 1, 2 of this report), at a diameter of 90 mm; D, holotype of *Proptychites buxtorfi* Renz and Renz (1948: pl. 7, fig. 1b), at a diameter of approximately 50 mm; E, holotype of

History (Spath, 1934: 174). The small number of available specimens does not permit construction of a meaningful graph. On the basis of the available specimens the differences in the width of the umbilicus between *P. decipiens* and *P. krafftii* are 5 percent or less; from our experience with many other species of these Scythian ammonoids this is well within the range of intraspecific variation seen in most species. The slight difference in the suture, especially in the auxiliary series (Fig. 11G-J), I likewise do not consider of specific importance.

Arthaber's two illustrated specimens of *Proptychites hakki* (1911: pl. 22(6), figs. 1, 2) are very poorly preserved. The holotype (Arthaber, 1911: pl. 22(6), fig. 1) is illustrated here on Plate 12, figure 3. The specimen is preserved only on one side and is slightly crushed. The paratype (Arthaber, 1911, pl. 22(6), fig. 2) is so badly preserved and weathered that only a portion of the phragmocone with the suture exposed offers data of value. The most apparent difference between *P. hakki* and *P. decipiens* is in the relative diameter of the umbilicus. In this regard, however, the two specimens of *P. hakki* are larger by a factor of at least two than all the other specimens from the *Subcolumbites* fauna of Albania and Chios that are here assigned to *P. decipiens*. From the observations that can be made on these specimens, it appears that the relative size of the umbilicus increases as the conch gets larger. The other features of the conch—whorl shape, degree of compression, and suture—are distinctly

of the pattern of the type of *P. decipiens*.

The contemporaneous *Subcolumbites* fauna from Chios includes what I consider typical representatives of *P. decipiens*, which was at least partially recognized by Renz and Renz (1948). The papers by Spath (1930, 1934) strangely enough were not known to Renz and Renz (1948). From study of their Chios fauna they came to the conclusion that the Albanian *Proptychites latifimbriatus* (non de Koninck) Arthaber was not conspecific with the Salt Range type of this species, and introduced the new name *Proptychites balcanicus* Renz and Renz (1948: 66). A substitute name for the Albanian species, *P. decipiens*, had already been introduced by Spath in 1930. A second species in the Chios fauna—*Proptychites lawrencianus* (de Koninck) mut. *postindica* Renz and Renz—was recognized, but this is no more than a poorly preserved *P. decipiens* lacking the radial ribs.

Occurrence. *Subcolumbites* fauna of Albania and Chios.

Repository. The following specimens are in the Paleontological Institute, Vienna: holotype, *Proptychitoides decipiens* Spath (= *Proptychites latifimbriatus*,—Arthaber, 1911: pl. 19(3), figs. 2a-c [non de Koninck]); syntype, *Proptychites krafftii* Arthaber, 1911: pl. 19(3), figs. 3a-c (Pl. 4, figs. 1, 2 of this report); holotype *Meekoceras hakki* Arthaber, 1911: pl. 22(6), fig. 1a-c (Pl. 18, fig. 3 of this report); paratype, *Meekoceras hakki* Arthaber, 1911: pl. 22(6), fig. 2. The following specimens are in the

←

Flemingites pseudorusselli Renz and Renz (1948: pl. 7, fig. 3c), at a diameter of approximately 50 mm; F, type specimen of *Proptychites mahamedis* var. *applanata* Renz and Renz (1948: pl. 6, fig. 3b), at a diameter of approximately 40 mm; G-J, *Proptychitoides decipiens* Spath; G, syntype of *Meekoceras hakki* Arthaber (1911: pl. 22(6), fig. 2), at a diameter of 99 mm; H, syntype of *Meekoceras hakki* Arthaber (1911: pl. 22(6), fig. 1c), at a diameter of 60 mm; I, holotype (= *Proptychites latifimbriatus* non de Koninck, Arthaber (1911: pl. 19(3), fig. 2c), at a diameter of 73 mm; J, syntype *Proptychites krafftii* Arthaber (1911: pl. 19(3), fig. 3c), at a diameter of 65 mm; K, holotype *Pracarnites kummeli* Popov (1962: 188, fig. 10), at a diameter of 100 mm; L, holotype of *Proptychites arthaberi* Welter (1922: pl. 2, figs. 1-3), at a diameter of 45 mm.

Specimens of figures A-C, G-J from *Subcolumbites* fauna of Albania, specimens of figures D-F from same fauna on Chios, specimen of figure K from Olenek River region, Siberia, specimen of figure L from Black E, Nifoeokoka, Timor.

Natural History Museum, Basel: plesio-type, *Proptychites balcanicus* Renz and Renz (1948: pl. 5, fig. 9) NHMB J13721; unfigured paratypes NHMB 13722; holotype, *Proptychites laurencianus* (de Koninck) mut. *postindica* Renz and Renz (1948: pl. 5, fig. 8) NHMB J13725.

Proptychitoides trigonalis (Arthaber)

Plate 9, figures 1–4; Plate 10, figures 1–4; Plate 11, figure 5; Text-figure 11

Proptychites trigonalis Arthaber, 1911: 225, pl. 19(3), fig. 4; Diener, 1915: 232.

Proptychitoides trigonalis.—Spath, 1934: 174.

Proptychites bertisci Arthaber, 1911: 225, pl. 19(3), fig. 5; Diener, 1915: 231.

Proptychitoides bertisci.—Spath, 1934: 174.

Proptychites obliqueplicatus.—Arthaber (non Waagen), 1911: 226, pl. 20(4), fig. 1.

Proptychitoides (?) *nopcsai* Spath, 1934: 175 (= *Proptychites obliqueplicatus*.—Arthaber, non Waagen).

Meckoceras mohamedis Arthaber, 1911: 248, pl. 22(6), fig. 3.

Proptychites mahomedis.—Diener, 1915: 232.

Proptychitoides mahomedis.—Spath, 1934: 175, fig. 51d.

Proptychites mahomedis var. *applanata* Renz and Renz, 1947: 61, 76; Renz and Renz, 1948: 64, pl. 6, figs. 3–3b.

Proptychites ktenasi Renz and Renz, 1947: 61, 76; Renz and Renz, 1948: 65, pl. 6, figs. 1–1b.

Proptychites arthaberi.—Renz and Renz (non Welter) 1947: 61; Renz and Renz, 1948: 65, pl. 7, figs. 4–4b; pl. 5, figs. 7–7b.

Proptychites mistardisi Renz and Renz, 1947: 61, 77; Renz and Renz, 1948: 67, pl. 5, figs. 10–10b.

Proptychites buxtorfi Renz and Renz, 1947: 61, 77; Renz and Renz, 1948: 68, pl. 7, figs. 1–1b.

Koninckites bernoullii Renz and Renz, 1947: 61, 76; Renz and Renz 1948: 58, pl. 5, figs. 5–5a, pl. 6, figs. 2–2a, pl. 7, figs. 2–2a (var.).

Flemingites pseudorusselli Renz and Renz, 1947: 60, 76; Renz and Renz, 1948: 54, pl. 7, figs. 3–3c.

Monophyllites (*Leiophyllites*) *dieneri* Arthaber var. *involuta*.—Renz and Renz, 1947: 61; Renz and Renz, 1948: 75, pl. 5, figs. 1–1b.

Monophyllites (?) *Schizophyllites* *pseudohara* Renz and Renz, 1947: 61, 78; Renz and Renz, 1948: 78, pl. 5, figs. 3–3b.

In contrast to the compressed, more or less involute forms of *Proptychitoides* (e.g.,

P. decipiens) in the *Subcolumbites* fauna of Albania and Chios, there is a more inflated form, with a trigonal whorl section, and generally some form of radial ribs. Arthaber (1911) recognized four species within this “inflated” group, and Renz and Renz (1948) recognized six species and one new variety. The main differences between all these “species” are in the degree of inflation of the whorls and degree of lateral ornamentation. There are thus 10 species plus one variety recognized for this group. Of these, seven species and one variety were established on the basis of a single specimen each, one species was recognized from two specimens, one species on the basis of three specimens, and one species on the basis of five specimens; in summary 18 specimens of this inflated form of *Proptychitoides* gave rise to 10 species and one variety. Thirteen of these specimens are still preserved and were re-examined for this study. The measurements of these specimens are tabulated in Table 27.

The holotype (Plate 9, figures 3, 4) is a poorly preserved phragmocone showing the trace of the umbilical seam for an additional three-quarter revolution. The umbilicus is broad and open with steep umbilical walls. The whorl section is trigonal in outline with a narrowly rounded venter. The flanks are slightly crushed but, in spite of this, on the adoral half revolution the flanks are slightly concave. This specimen appears to be the inner whorls of what was originally a very large specimen like the holotype of *Proptychites ktenasi* Renz and Renz (1948: pl. 6, fig. 1). Due to poor preservation no surface ornamentation is preserved on the type specimen of *P. trigonalis*.

Proptychitoides bertisci Arthaber (1911: pl. 19(3), fig. 5; Pl. 9, figs. 1, 2 of this report) represents one direction of variation in its very broad, depressed whorl section. Most of the other forms included in *Proptychitoides trigonalis* are variants towards more compressed whorl sections and the development of radial ribs. One

TABLE 27. MEASUREMENTS OF *PROPTYCHITOIDES TRIGONALIS* (ARTHABER) FROM THE *SUBCOLUMBITES* FAUNAS OF ALBANIA AND CHIOS.

No.	D	W	H	U	W/D	H/D	U/D
1.	123.0	45.7?	60.2	24.2	37.2?	48.9	19.7
2.	90.5	30.0	38.8	28.4	33.8	42.9	31.4
3.	77.8	?	37.3	21.4	?	47.9	27.5
4.	77.0	35.0	38.5	16.2	45.5	50.0	21.0
5.	76.2	28.5?	35.0	19.1	37.4	45.9	25.1
6.	73.8	38.0?	31.7	21.7	51.5?	42.9	29.4
7.	68.6	?	32.1	16.0	?	46.8	23.3
8.	65.8	?	28.1	19.0	?	42.7	28.9
9.	65.6	17.8	26.7	19.8	27.1	40.7	30.2
10.	61.4	21.7	28.7	14.6	35.3	46.7	23.8
11.	60.6	21.0	26.3	16.0	34.7	43.4	26.4
12.	31.8	10.4	14.8	9.3	32.7	46.5	29.2
13.	30.3	12.6?	13.5	8.4	41.6?	44.6	27.7

1. Holotype, *Proptychites ktenasi* Renz and Renz (1948: pl. 6, fig. 1), NHMB J13715.
2. Lectotype (herein designated), *Meekoceras mahomedis* Arthaber (1911: pl. 22(6), fig. 3), PIUV.
3. Holotype, *Koninckites bernoullii* Renz and Renz (1948: pl. 6, fig. 2), NHMB J13707.
4. Holotype, *Proptychites trigonalis* Arthaber (1911: pl. 19(3), fig. 4a-c), PIUV.
5. Holotype, *Proptychites buxtorfi* Renz and Renz (1948: pl. 7, fig. 1), NHMB J13726.
6. Holotype, *Proptychites bertisci* Arthaber (1911: pl. 19(3), fig. 5), PIUV.
7. Paratype, *Koninckites bernoullii* Renz and Renz (1948: pl. 7, fig. 2), NHMB J13709.
8. Paratype, *Koninckites bernoullii* Renz and Renz (1948: pl. 5, fig. 5), NHMB J13708.
9. Holotype, *Flemingites pseudorussellii* Renz and Renz (1948: pl. 7, fig. 3), NHMB J13698.
10. Plesiotype, *Proptychites arthaberi*,—Renz and Renz (non Welter) (1948: pl. 7, fig. 4), NHMB J13717.
11. Holotype, *Proptychites mohamedis* Arthaber var. *applanata* Renz and Renz (1948: pl. 6, fig. 3), NHMB J13714.
12. Plesiotype, *Proptychites arthaberi*,—Renz and Renz (non Welter) (1948: pl. 5, fig. 7), NHMB J13718.
13. Holotype, *Proptychites mistardisi* Renz and Renz (1948: pl. 5, fig. 10), NHMB J13723.

of the more extreme forms is *Meekoceras mahomedis* (Plate 10, figs. 1, 2). Many of the specimens from the *Subcolumbites* fauna of Chios described as species of *Proptychites*, *Koninckites*, and *Flemingites* as listed in the synonymy are intermediate in degree of whorl inflation and ornamentation between *P. trigonalis* and *P. mahomedis*. The number of available specimens does not allow a statistical analysis of this variation in conch form. Unless one is willing to take note of the large amount of variation potentially possible within many ammonite species where there is an abundance of data, one is left with a name per speci-

men, as has happened within this group. The pattern of the suture (Fig. 11A-F) and degree of evolution in all these specimens ties them together; on this background the variation in whorl width and ornamentation is much more understandable.

The associated *P. decipiens* differs in its greater involution and pattern of ornamentation. The basic pattern of the suture in these two species remains the same (Fig. 11G-J). The suture and general conch features in the other species of *Proptychitoides* easily distinguish them from *P. trigonalis*.

Occurrence. *Subcolumbites* fauna of Albania and Chios.

Repository. The following specimens are in the Paleontological Institute, University of Vienna: holotype, *P. trigonalis* Arthaber, 1911: pl. 19(3), fig. 4 (Pl. 5, figs. 3, 4 of this report); holotype *P. bertisci* Arthaber, 1911: pl. 19(3), fig. 5 (Pl. 5, figs. 1, 2 of this report); holotype, *P. (?) nopscai* Spath, 1934: 175 (= *Proptychites obliqueplicatus*,—Arthaber, 1911: pl. 20(4), fig. 1, non Waagen (Pl. 6, figs. 3, 4 of this report); holotype, *Meekoceras mahomedis* Arthaber, 1911: pl. 22(6), fig. 3 (Pl. 6, figs. 1, 2 of this report). The following specimens are in the Natural History Museum, Basel: holotype, *Proptychites mohamedis* var. *applanata* Renz and Renz (1948: pl. 6, fig. 3) NHMB J13714; unfigured paratypes NHMB J13835; holotype, *Proptychites ktenasi* Renz and Renz (1948, pl. 6, fig. 1) NHMB J13715; unfigured paratype NHMB J13716; plesiotypes, *Proptychites arthaberi*,—Renz and Renz (1948: pl. 5, fig. 7) NHMB J13718, (pl. 7, fig. 4) NHMB J13717; unfigured paratypes from Maradovuno NHMB J13719, from Kephlovuno NHMB J13720; holotype, *Proptychites mistardisi* Renz and Renz (1948: pl. 5, fig. 10) NHMB J13723; unfigured paratypes NHMB J13724; holotype *Proptychites buxtorfi* Renz and Renz (1948: pl. 7, fig. 1) NHMB J13726; holotype, *Koninckites bernoullii* Renz and Renz (1948: pl. 6,

fig. 2) NHMB J13707; paratypes (pl. 5, fig. 5) NHMB J13708, (pl. 7, fig. 2) NHMB J13709; holotype *Flemingites pseudorusselli* Renz and Renz (1948: pl. 7, fig. 3) NHMB J13698; unfigured paratype NHMB J13699; figured specimen *Monophyllites* (*Leiophyllites*) *dieneri* var. *involuta* Renz and Renz (1948: pl. 5, fig. 1) NHMB J13747; unfigured paratype NHMB J13748; holotype, *Monophyllites* (*Schizophyllites*) *pseudohara* Renz and Renz (1948: pl. 5, fig. 3) NHMB J13763.

Proptychitoides arthaberi (Welter)

Plate 25, figures 1, 2; Text-figure 11

Proptychites arthaberi Welter, 1922: 102, pls. 156(27), figs. 1-4; Kutassy, 1933: 625.

Proptychitoides arthaberi,—Spath, 1934: 177; Kummel, 1961: 525.

This species is of the general conch form of *Proptychitoides trigonalis*. Welter's type and only specimen is well preserved but incomplete; the illustration of the complete specimen (Welter, 1922: pl. 156(2), fig. 4) is slightly inaccurate in that the umbilicus is shown too small. The umbilicus is approximately 21 percent the diameter of the conch rather than 18 percent as indicated by Welter's figure. An additional specimen that is of considerable interest, illustrated here on Plate 25, figures 1, 2, is available in the collections of the Geological Institute, Amsterdam. First, it has a suture nearly identical to that of the type specimen illustrated by Welter (Fig. 11L). The whorl section, however, is more inflated and more trigonal in cross-section. Likewise, the whorl sides bear more prominent radial folds. However, the character of the venter, umbilical shoulder and wall, and degree of involution are the same in the two specimens.

Occurrence. Welter's type specimen came from Block E, Nifoekoko, Timor, with the manganese coated fossils. The specimen in the Amsterdam collections has no label but is a manganese coated specimen like those from Block E at Nifoekoko.

Repository. Holotype in the Paleontologi-

cal Institute, Bonn; two topotypes are in the British Museum (Natural History) C33748-9; the specimen figured here is in the Geological Institute, University of Amsterdam.

Proptychitoides tunglanensis Chao

Proptychitoides tunglanensis Chao, 1959: 80, 245, pl. 20, figs. 11-12, text-fig. 25a.

Proptychitoides compressus Chao, 1959: 80, 246, pl. 20, figs. 9-10, text-fig. 25b.

Proptychitoides ? *simplex* Chao, 1959: 81, 246, pl. 20, figs. 7-8, text-fig. 25c.

The three species brought together here were each based on single, poorly preserved specimens from three different localities of the *Subcolumbites* fauna in Kwangsi, China. They likewise represent three different growth stages. Chao (1959) made no reference to the differences between his three species. On the basis of the very poor illustrations, the brief and incomplete descriptions, and taking into account the poor preservation, there appears to be little real basis for separating these three forms.

This Kwangsi species is of the general morphological type of *P. decipiens* from Albania and Chios. The available specimens and their poor preservation do not allow more detailed comparison. This species could be conspecific with the Albanian and Chios *P. decipiens* or possibly *P. arthaberi* from Timor. For the moment it is thought best to retain an independent status for these Kwangsi specimens.

Occurrence. The holotype of *P. tunglanensis* came from the *Subcolumbites* fauna on the western side of Chashanao between Tunglan and Hochieh districts (Chao collection 610); the holotype of *P. compressus* came from a limestone block in the Lolou village in the Linglo district, associated with *Procamites kokeni* (Chao collection 542b); the holotype of *P. simplex* came from the *Subcolumbites* fauna 1.5 km north of Yali in the Fengshan district (Chao collection 546), all in Kwangsi, China.

Proptychitoides kummeli (Popov)

Text-figure 11

Procarinites kummeli Popov, 1962a: 187, pl. 2, fig. 5.

This species has the general conch architecture of *P. arthaber* and *P. trigonalis*. Its suture is very much like that of the Timor *P. arthaber* (Fig. 11K) and not like that of any known species of *Procarinites*.

Occurrence. From along the Nikabit River in the Olenek River region, Siberia. Popov (1961: 177, 188) lists the specimens, with questions, as having come from his *Olenekites* Zone.

Genus *Procarinites* Arthaber, 1911

Type species, *Parapopanoceras kokeni* Arthaber, 1908

Procarinites kokeni (Arthaber)

Plate 11, figures 1–4; Plate 12, figures 1, 2; Plate 13, figures 1–8; Text-figures 12, 13

Parapopanoceras kokeni Arthaber, 1908: 259, pl. 11(1), figs. 1a–c, 2a, b.

Hedenstroemia sp. Arthaber, 1908: 284, pl. 3, fig. 2.

Procarinites kokeni (Arthaber) 1911: 215, pl. 17(1), figs. 16, 17, pl. 18(2), figs. 1–5; Diener, 1915: 228; Diener, 1917: 167; C. Renz, 1928: 155; Renz and Renz, 1947: 61; Renz and Renz, 1948: 81, pl. 8, figs. 5, 6–6a, 7–7a, 8–8a, 9–9a, pl. 9, figs. 2–2a; Kummel, 1966: 390, pl. 2, figs. 10–13; Kummel, 1968b: 493, pl. 1, fig. 16.

Procarinites kokeni var. *evoluta* Renz and Renz, 1947: 61; Renz and Renz, 1948: 82, pl. 9, figs. 1–1a.

Procarinites kokeni var. *panteleimonensis* Renz and Renz, 1947: 61, 78; Renz and Renz, 1948: 82, pl. 8, figs. 3–3a, pl. 9, figs. 3–3a.

Procarinites acutus Spath, 1934: 183, pl. 5, figs. 4a, b (= *Hedenstroemia* sp. Arthaber, 1908: 284, pl. 3, fig. 2); Chao, 1959: 89, 255, pl. 32, figs. 8, 9, pl. 33, figs. 1–8.

Procarinites skanderbegis Arthaber, 1911: 216, pl. 18(2), figs. 6, 7; Diener, 1915: 229; C. Renz, 1928: 155; Renz and Renz, 1947: 61; Renz and Renz, 1948: 82, pl. 8, figs. 4–4a.

Procarinites andrusovi (Bajarunas, 1936: nomen nudum) Kiparisova, 1947: 132, pl. 28, figs. 2–4, text-figs. 11–13; Astakhova, 1960b: 149.

Procarinites oxynostus Chao, 1959: 88, 254, pl. 32, figs. 1–7, 10–12, text-fig. 28a–d.

Species of *Procarinites* have been differ-

entiated on the basis of the suture, the degree of inflation of the conch, the nature of the venter, and to some extent on the ornamentation. Much of the misconception that has existed about this species has been due directly to the relatively poor preservation and to the manner of treatment of this material.

The types of *Procarinites kokeni* (Arthaber) are two small, immature specimens, refigured here on Plate 13, figures 1–4. Only one side of either of these specimens is preserved. Noteworthy of the smaller of these two specimens are the broadly arched lateral areas and the round umbilical shoulders. The larger specimen has broader lateral areas and abruptly rounded umbilical shoulders and nearly vertical umbilical walls.

In his monograph on the Këira, Albania, fauna Arthaber (1911) stated he had 45 specimens for study, and he illustrated six of these. Unfortunately, only three of the illustrated specimens are still available, and these are refigured here. Arthaber did not give measurements of any of his specimens.

In addition to *Procarinites kokeni*, Arthaber (1911) recognized one additional species, *P. skanderbegis*. For this species he records eight specimens of which the two illustrated types are available for study. This species was differentiated on the basis of suture, degree of conch inflation, and ornamentation. In regards to the suture it was the absence of minor adventitious elements in the ventral lobe to which Arthaber pointed. The modification and development of the suture in the ventral region progressively change with growth, and comparing the suture of *P. skanderbegis* with that of *P. kokeni* at a comparable growth stage shows that they differ in only the smallest details (Fig. 12A–C, E, F).

Assessment of the significance of conch shape and ornamentation was not possible until the discovery of the *Subcolumbites* fauna of Chios which yielded a large number of specimens of *Procarinites*. On Table

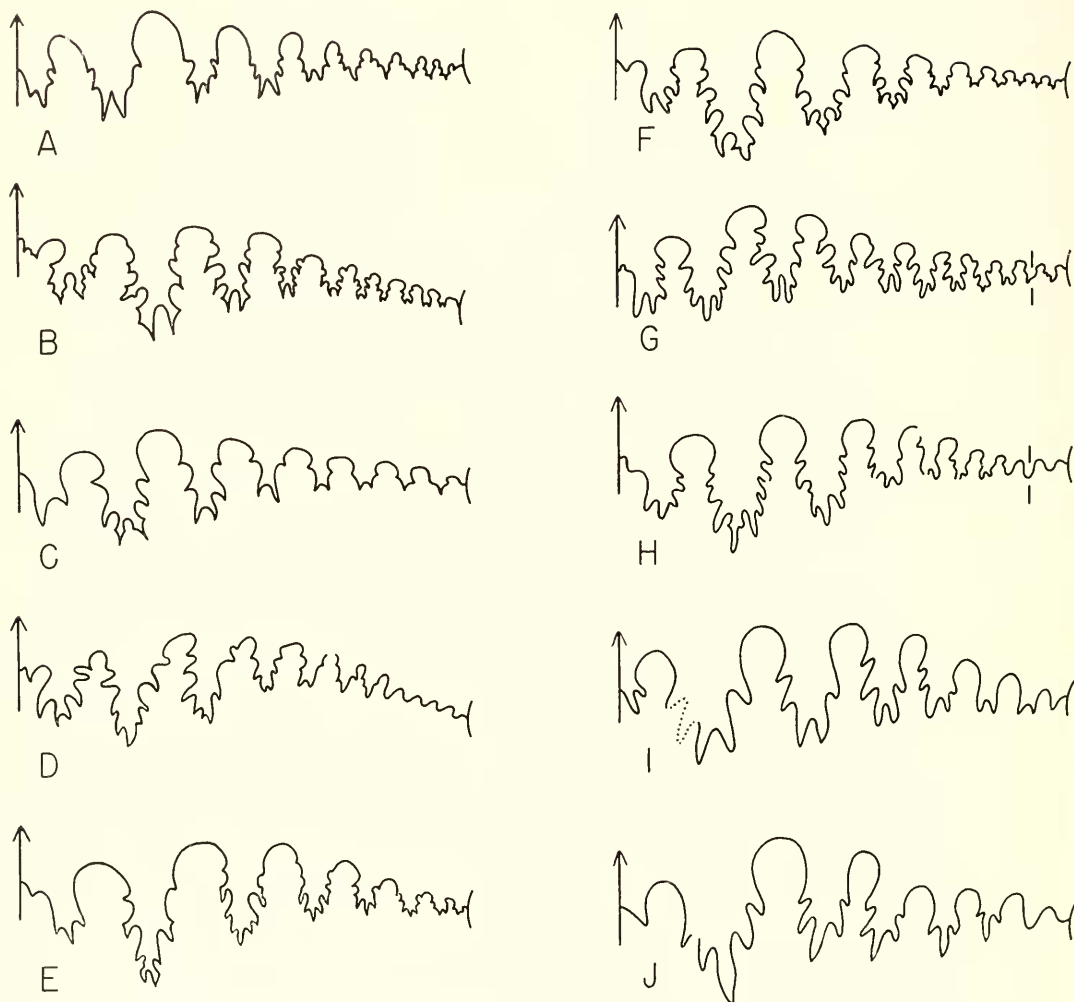


Figure 12. Diagrammatic representation of the sutures of *Pracarnites kakeni* (Arthaber), *Pracarnites immaturus* (Kiparisova), and *Pracarnites lalauensis* (Chao). A–G, *Pracarnites kakeni*; A, lectotype (Arthaber, 1908: pl. 11(1), fig. 1c), at a diameter of 33 mm; B, plesiatype (Arthaber, 1911: pl. 18(2), fig. 3), at a diameter of 34 mm; C, plesiatype (Arthaber, 1911: pl. 18(2), fig. 2c), at a diameter of about 21 mm; D, holotype of *Pracarnites oxynostus* Chao (1959: fig. 28a), at a diameter of approximately 80 mm; E, paralectotype of *Pracarnites skanderbegis* Arthaber (1911: pl. 18(2), fig. 6c), at a diameter of 50 mm; F, lectotype of *Pracarnites skanderbegis* Arthaber (1911: pl. 18(2), fig. 7c), at a diameter of 55 mm; G, syntype of *Pracarnites andrusovi* Kiparisova (1947: 132, fig. 12), at a diameter of approximately 50 mm; H, holotype of *Megaphyllites immaturus* Kiparisova (1947: 130, fig. 8), at a diameter of approximately 40 mm; I, J, *Digitaphyllites lalauensis* Chao (1959, figs. 29a, b), both sutures from whorl height of approximately 10 mm.

Specimens of Figures A–C, E, F from *Subcolumbites* fauna of Albania, of figure G, from upper Scythian of the Mangyshlak Peninsula, D, I, J, from *Subcolumbites* Zone of Kwangsi, China, and H, from *Subcolumbites* fauna of the Pri-morye Region.

Figure 13. Variation in the width (W) and height (H) of whorls, and umbilical diameter (U) of *Pracarnites kakeni* (Arthaber). Specimens from Albania and Chios are marked with a dot, those of *Pracarnites skanderbegis* with a cross, specimen 69 from the Mangyshlak Peninsula with a triangle, and specimens 64–68 and 70–74 from Kwangsi, China, with an X. The data on this graph are from Table 28.

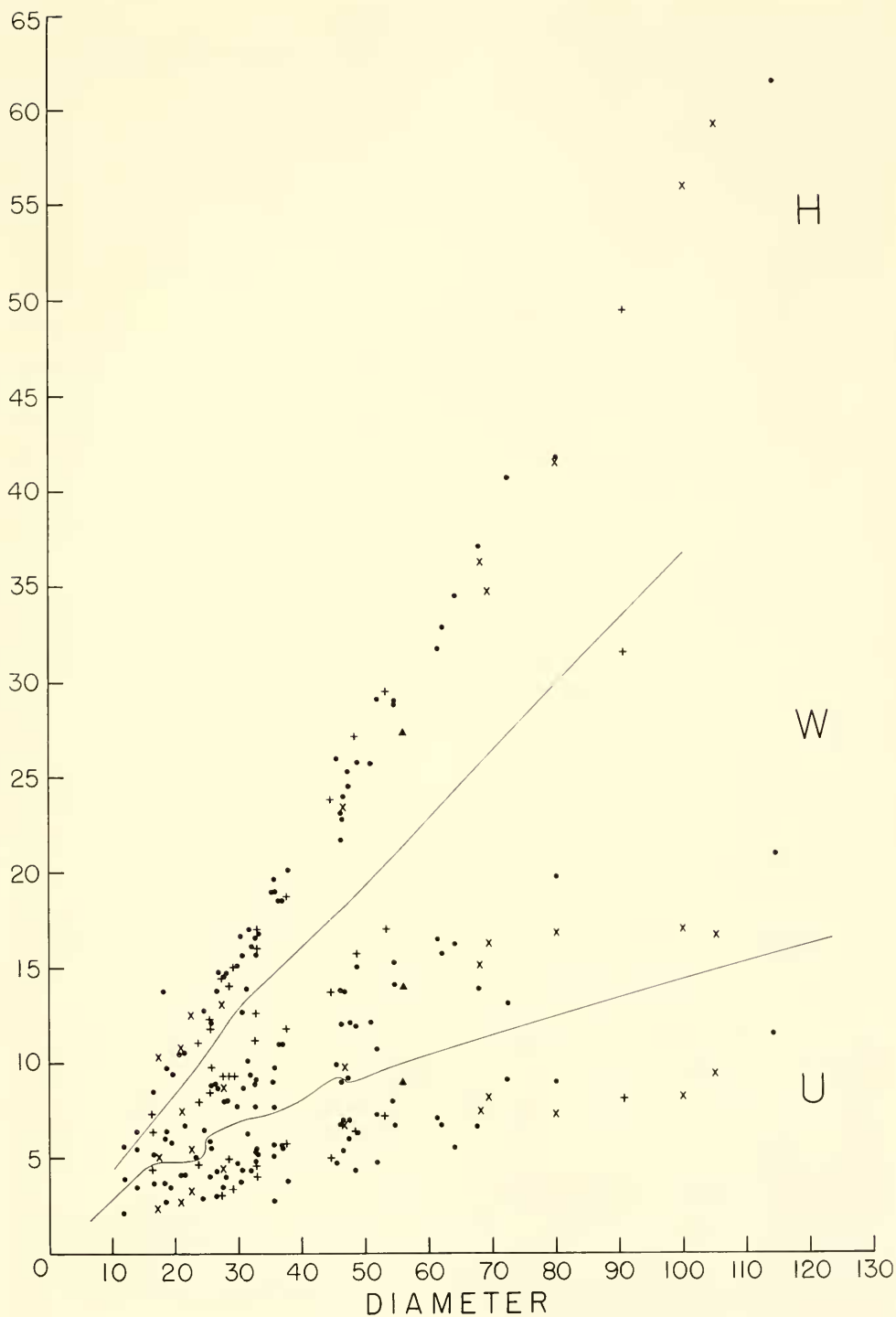


TABLE 28. MEASUREMENTS OF *PROCARNITES KOKENI* (ARTHABER) FROM THE SUBCOLUMBITES FAUNAS OF ALBANIA AND CHIOS. SPECIMENS 1-63: THOSE IDENTIFIED BY ARTHABER AND BY RENZ AND RENZ AS *P. KOKENI* MARKED WITH A DOT, THOSE AS *P. SKANDERBEGIS* WITH A CROSS. SPECIMENS 64-74 MARKED BY AN X; SPECIMEN 69 IS FROM SOUTHERN U.S.S.R., SPECIMENS 64-68, 70-74 ARE FROM KWANGSI, CHINA.

	D	W	H	U	W/D	H/D	U/D		D	W	H	U	W/D	H/D	U/D
1.	114.2	21.0?	61.5	11.6	18.4?	53.9	10.2	38.	31.9	9.3	17.0	4.4	29.2	53.3	13.8
2.	90.5?	31.5?	49.5?	8.2	34.8?	54.7?	9.1?	39.	31.2	10.1	13.9	6.3	32.4	44.6	20.2
3.	80.0	19.7	41.6?	9.0?	24.6	52.0?	11.3?	40.	30.7	8.6	15.6	4.4	28.0	50.8	14.3
4.	72.2	13.1	40.6	9.2	18.1	56.2	12.7	41.	30.3	12.6	16.7	3.8	41.6	55.1	12.5
5.	67.7	13.9	37.2	6.8	20.5	54.9	10.0	42.	29.9	7.7	15.2	4.7	25.8	50.8	15.7
6.	64.0	16.2	34.5	5.6	25.3	53.9	8.8	43.	29.1	9.3	15.0	3.3	31.9	51.5	11.3
7.	62.0	15.7?	32.8	6.8	25.3?	52.9	10.9	44.	28.3	9.3	14.0	5.0	32.9	49.5	17.7
8.	61.1	16.5	31.7	7.1	27.0	51.9	11.6	45.	28.0	8.0	14.7	4.0	28.6	52.5	14.3
9.	54.5	15.2	28.8	6.7	27.9	52.8	12.3	46.	27.8	8.0	14.6	3.5	28.8	52.5	12.6
10.	54.5	14.1	28.9	8.0	25.9	53.0	14.7	47.	27.3	9.3	14.4	3.0	34.1	52.7	10.9
11.	53.0?	17.0?	29.5	6.9	32.1?	55.7?	13.0?	48.	26.8	8.6	14.8	4.3	32.1	55.2	16.0
12.	51.8	10.7	29.0	4.7	20.7	56.0	9.1	49.	26.2	8.9	13.8	3.0	33.9	52.7	11.5
13.	50.8	12.1	25.6	7.3	23.8	50.4	14.4	50.	25.8	8.8	12.1	5.6	34.1	46.9	21.7
14.	48.7	15.0?	25.8	6.3	30.8?	52.9	12.9	51.	25.5	9.7	12.3	4.0?	38.0	48.2	15.7?
15.	48.4	15.6	27.2	4.8	32.2	56.2	9.9	52.	25.3	8.5	11.7	5.9	33.6	46.2	23.3
16.	48.4	11.9	27.2	4.4	24.6	56.2	9.1	53.	24.5	6.4	12.7	2.8	26.1	51.8	11.4
17.	47.3	12.1	24.5	7.0?	25.6	51.8	14.8?	54.	23.6	8.0	11.0	4.7	33.9	46.6	19.9
18.	47.2	9.2	25.2	6.0	19.5	53.4	12.7	55.	21.6	6.6	10.5	4.1	30.6	48.6	18.9
19.	46.5	13.7?	24.0	5.4	29.5?	51.6	11.6	56.	20.8?	?	10.4	4.2	?	50.0	20.2
20.	46.4	12.0	22.8	7.0	25.9	49.1	15.1	57.	19.3	5.8	9.5	3.5	30.1	49.2	18.1
21.	46.2	?	21.7	9.0	?	46.9	19.5	58.	18.6	6.4	9.8	2.7	34.4	52.7	14.5
22.	46.1	13.8	23.1	6.8	29.9	50.1	14.8	59.	18.2	6.0	13.8	3.7	32.9	75.8	20.3
23.	45.4	9.9	26.0	4.7	21.8	57.3	10.4	60.	16.8	5.2?	8.5	3.6	30.9	50.6	21.4
24.	44.5	13.7	23.8	5.0	30.8	53.5	11.2	61.	16.1	6.4	7.2	4.3	39.8	44.7	26.7
25.	37.7	?	20.1	3.8	?	53.3	10.1	62.	14.0	5.5	6.3	3.5	39.3	45.0	25.0
26.	37.2	11.6	18.8	5.7?	31.2	50.5	15.3?	63.	12.0	3.9	5.7	2.1	32.5	47.5	17.5
27.	36.8	11.0	18.6	5.5	29.8	50.5	14.9	64.	105.0	16.7	59.2	9.4	16.0	56.0	8.9
28.	36.5	11.0	18.5	5.6	30.1	50.7	15.3	65.	100.0?	17.0	56.0?	8.2	17.0	56.0	8.2
29.	35.7	7.7	19.6	5.1	21.6	54.9	14.3	66.	80.0	16.8	41.5	7.3	20.0	52.0	9.0
30.	35.6	9.7	19.0?	5.7?	27.2	53.4?	16.0?	67.	69.2	16.2	33.6	8.2	16.6	48.0	12.0
31.	35.4	9.0	19.0	2.8	25.4	53.7	7.9	68.	68.0	15.1	36.2	7.5	22.2	52.0	10.0
32.	33.0	?	16.8	5.2	?	50.9	15.8	69.	56.0	14.0	27.4	9.0			
33.	32.8	12.5	17.0	4.1	38.1	51.8	12.5	70.	46.6	9.7	23.5	6.8	20.0	50.0	14.6
34.	32.8	9.2	15.6	5.3	28.0	47.6	16.2	71.	27.4	8.6	13.0	4.5	21.2	47.8	16.0

1. Plesiotype (Arthaber, 1911: pl. 18(2), figs. 5a, b), PIUV.
2. Syntype, *P. skanderbegis* Arthaber (1911: pl. 18(2), figs. 7a, b), PIUV.
3. 8, 9, 12, 16, 18, 23, 27, 29-31, 35, 45, 46, 49, 53, 58, 59, 62, 63. Unfigured specimens, *P. kokeni* Maradovuno, Chios, NHMB J13774-13779.
4. Plesiotype,—Renz and Renz (1948: pl. 8, fig. 6), NHMB J13769.
5. Plesiotype,—Renz and Renz (1948: pl. 8, fig. 7), NHMB J13772.
6. Plesiotype,—Renz and Renz (1948: pl. 8, fig. 9), NHMB J13773.
7. Plesiotype,—Renz and Renz (1948: pl. 8, fig. 8), NHMB J13770.
- 10, 17, 22, 37. Unfigured paratypes, *P. kokeni* var. *panteleimonensis*, Maradovuno, Chios, NHMB J13786.
11. Syntype, *P. skanderbegis* Arthaber (1911: pl. 18(2), figs. 6a, b), PIUV.
13. Plesiotype,—Renz and Renz (1948: pl. 9, fig. 2), NHMB J13771.
14. Plesiotype (Arthaber, 1911: pl. 17(1), figs. 17a, b), PIUV.
15. Plesiotype, *P. skanderbegis*, Renz and Renz (1948: pl. 8, fig. 4), NHMB J13788.
19. Plesiotype,—Renz and Renz (1948: pl. 8, fig. 5), NHMB J13768.
- 20, 28, 38, 40, 41, 42, 48, 50, 55, 57, 60. Unfigured paratypes, *P. kokeni* var. *evoluta*, Maradovuno, Chios, NHMB J13782.
21. Syntype, *P. kokeni* var. *panteleimonensis* Renz and Renz (1947: 61, 78; 1948: pl. 9, fig. 3), NHMB J13785.
- 24, 26, 33, 36, 43, 44, 47, 51, 52, 54, 61. Unfigured specimens, *P. skanderbegis* Maradovuno, Chios, NHMB J13789.
25. Plesiotype (Arthaber, 1911: pl. 17(1), figs. 16a, b), PIUV.
32. Syntype (Arthaber, 1908: pl. 11(1), figs. 1a-c), PIUV.
34. Syntype, *P. kokeni* var. *panteleimonensis* Renz and Renz (1947: 61, 78; 1948: pl. 8, fig. 3), NHMB J13784.
39. Holotype, *P. kokeni* var. *evoluta* Renz and Renz (1947: 61; 1948: pl. 9, fig. 1), NHMB J13781.

TABLE 28. *Continued*

	D	W	H	U	W/D	H/D	U/D		D	W	H	U	W/D	H/D	U/D
35.	32.7	7.7	16.7	5.5	23.5	51.1	16.8	72.	22.6	5.5	12.5	3.2	23.8	53.4	13.2
36.	32.5	11.2	16.0	4.7	34.5	49.2	14.5	73.	21.0	7.5	10.7	2.7	34.0	51.0	13.0
37.	32.2	8.9	16.1	4.8	27.6	50.0	14.9	74.	17.2	5.0	10.4	2.4	27.8	60.0	14.0

56. Syntype (Arthaber, 1908: pl. 11(1), figs. 2a, b), PIUV.
 64, 65, 70, 72. *Procarnites acutus*,—Chao (1959: 255–256).
 66. Holotype, *P. oxynostus* Chao (1959: 255).
 67, 68, 71, 73, 74. Paratypes, *P. oxynostus* Chao (1959: 255).
 69. *Procarnites andrusovi* Kiparisova (1947: 132).

28 are the measurements of 44 specimens assigned by Renz and Renz (1948) to *Procarnites kokeni* and 12 specimens these authors assigned to *P. skanderbegis*. These data are plotted on Figure 13. It can readily be seen that no distinction can be made between these two species on whorl height or umbilical diameter. In respect to whorl width the specimens assigned to *P. skanderbegis* tend to be thicker, but there is complete gradation with more compressed forms which had been placed in *P. kokeni*. The plot of Arthaber's two figured types on Figure 13 likewise shows that these are no more than slightly inflated forms which can much better be considered as part of *P. kokeni*.

The ornamentation of the larger of Arthaber's two figured types (Pl. 11, figs. 1, 2) consists of very faint radial folds and slightly accentuated growth lines every millimeter or so. The specimen is not well preserved so the complete pattern of this ornamentation is not known. None of the specimens from Chios assigned by Renz and Renz to *P. skanderbegis* show any ornamentation. Two specimens of *P. kokeni* (Renz and Renz, 1948: pl. 8, figs. 3, 5 and pl. 9, fig. 3) show faint radial ribs or falcoid ribs. The poor state of preservation of the Albanian and Chios *Subcolumbites* fauna is an important factor which does not allow full evaluation of the nature of and variation of the ornamentation patterns. On the basis of the data available, ornamentation does not appear to be a criterion which can be used in this case for species discrimina-

tion. Thus the criteria used to distinguish *P. skanderbegis* from *P. kokeni* do not stand up on close examination.

Spath (1934: 183) separated one of Arthaber's varieties of *Procarnites kokeni* as a new species—*P. acutus*. The distinction was made on the basis of an acute to oxynote venter. He (Spath) also mentions a form which he considered transitional with *P. kokeni* from the same Albanian *Subcolumbites* fauna. Examination of the large number of specimens of *P. kokeni* from Chios clearly shows complete gradation from forms with acute venters like Spath's holotype of *P. acutus* (Spath, 1934: pl. 5, figs. 4a, b) to forms with broadly rounded venters. Arthaber insisted on minor aspects of the suture as important distinguishing features. Spath (1934: 183) was not able to see these differences clearly and correctly brought attention to the frequent loss of detail entailed in the grinding necessary to bring out the sutures on these Albanian specimens.

Procarnites andrusovi Bajarunas (Kiparisova, 1947) from the Mangyshlak Peninsula of the Caspian region is clearly conspecific with *P. kokeni*. Kiparisova distinguished her species on the basis of the greater width of the umbilicus and the addition of an adventive element in the ventral lobe. The umbilical width of *P. andrusovi* falls well within the variability in this feature in the population of *P. kokeni* from Chios (Fig. 12G). It has already been pointed out that variations in the ventral lobe are a function of ontogeny.

Unfortunately, the stratigraphic relations of the Mangyshlak Scythian ammonoids described to date are not well known. The data given by Bajarunas (1936) and Kiparisova (1947) are ambiguous. Recent publications on the Triassic strata of Mangyshlak did not discuss *P. andrusovi* but added some additional stratigraphic data (Astakhova, 1960a, b).

Chao (1959) recognized two species of *Procarnites* from Kwangsi, China. He had four specimens he assigned to *P. acutus* Spath and six specimens for which he erected a new species, *P. oxynostus*. The measurements of these forms are plotted on the graph of Figure 13. It can readily be seen that in terms of whorl heights and umbilical diameter these specimens are quite like *P. kokeni* from Chios. In terms of whorl width they are clearly of the compressed variety but yet within the range of variation in this feature in the material of *P. kokeni* from Chios. The minor differences in the suture pointed to by Chao are more likely expressions of poor preservation than any true genetic significance. These Kwangsi specimens are considered to be valid representatives of *Procarnites kokeni*.

This species was reported from Timor by Spath (1934, p. 182) on the basis of two specimens from Nifoekoko (*Prohungarites* fauna) in the British Museum (Natural History). This species is also present in Afghanistan (Kummel, 1968b) and West Pakistan (Kummel, 1966).

Occurrence. *Subcolumbites* faunas of Albania, Chios, Afghanistan, Kwangsi, China (Chao collection 542b), and Timor; from the *Pseudosagecceras* Zone of Astakhova (1960b) in the Mangyshlak Peninsula, Caspian region; from the *Prohungarites* fauna, Salt Range, West Pakistan.

Repository. The following specimens are in the Paleontological Institute, Vienna: lectotype (Arthaber, 1908, pl. 11(1), figs. 1a-c); paralectotype (Arthaber, 1908, pl. 11(1), figs. 2a, b); plesiotypes (Arthaber, 1911, pl. 17(1), figs. 16, 17, pl. 18(2), figs.

5, 6, 7). Topotypes, BMNH C22700-05, C22706-24, C22761-2, C22694-9, C34116-7, C22725, C22882. The specimens from Chios are in the Natural History Museum, Basel, and are as follows: plesiotypes *P. kokeni*, Renz and Renz (1948, pl. 8, fig. 5) NHMB J13768, (pl. 8, figs. 6-6a) NHMB J13769, (pl. 8, figs. 7-7a) NHMB J13772, (pl. 8, figs. 8-8a) NHMB J13770, (pl. 8, figs. 9-9a) NHMB J13773, (pl. 9, figs. 2-2a) NHMB J13771; unfigured specimens from Maradovuno NHMB J13774-13779, from Kephlovuno NHMB J13780; var. *panteleimoneus* Renz and Renz (1948, pl. 8, figs. 3-3a) NHMB J13784, (pl. 9, figs. 3-3a) NHMB J13785; unfigured specimens from Maradovuno NHMB J13786, from Kephlovuno NHMB J13787; var. *evoluta* Renz and Renz (1948, pl. 9, figs. 1-1a) NHMB J13781; unfigured specimens from Maradovuno NHMB J13782, from Kephlovuno NHMB J13783; plesiotype *P. skanderbegis*, Renz and Renz (1948, pl. 8, figs. 4-4a) NHMB J13788; unfigured specimens from Maradovuno NHMB J13789, from Kephlovuno NHMB J13790; topotypes MCZ 10021, 10022; specimens from West Pakistan, MCZ 9593-9595; specimens from Kotal-e-Tera, Afghanistan, MCZ 10154, 10155.

Procarnites immaturus (Kiparisova)

Text-figure 12

Megaphyllites immaturus Kiparisova, 1947: 130, pl. 27, figs. 1, 2, text-fig. 8; Kiparisova, 1954: 22, pl. 12, fig. 4; Kiparisova, 1961: 172, pl. 35, figs. 3-5, text-figs. 115-117; Tozer, 1965a: 39.

Procarnites modestus Tozer, 1965a: 38, pl. 1, figs. 1-6, text-fig. 12.

This species can be distinguished on the basis of faint radial constrictions; in all other features it is quite similar to *P. kokeni* (see illustration of suture, Figure 12H). Tozer (1965a) recognized the close resemblance between his *P. modestus* and *P. immaturus* but relied primarily on a slight difference in the umbilical diameter to separate the two species. Considering that

the specimens of *P. modestus* have crushed body chambers and the near identity in the other morphologic features, I can see no justification for separating these species.

Occurrence. *Subcolumbites* fauna, Cape Zhitkov, Primorye Region, Siberia, and Toad Formation, Halfway River area, British Columbia.

Procarinites lolouensis (Chao)

Text-figure 12

Digitophyllites lolouensis Chao, 1950: 5, pl. 1, figs. 4-6; Chao, 1959: 90, 256, pl. 32, figs. 13-19, text-figs. 29a, b.

Chao (1959) recognized that this species was a procarnitid but established a new genus for it because it differed from *Procarinites* in (1) having a wider umbilicus, (2) having a broadly arched venter rather than a narrow or acute one, encompassing a subquadratic whorl section, and (3) having a different suture. In the first place, the umbilicus compares very favorably in diameter to the specimen of *Procarinites kokeni* of comparable size from Chios. Chao gave measurements on four specimens of diameters from 30 to 27 mm; the umbilical diameters ranged from 6.0-4.5 mm. Among the specimens of *Procarinites kokeni* from Chios, those of a diameter of 30.3 to 26.8 mm have a range of diameter of 5-3 mm.

The more inflated, subquadrate whorl is quite distinctive. Finally, a comparison of the sutures of these Kwangsi specimens and those at the same relative conch size is shown on Figure 12I, J. The adventitious elements mentioned by Chao do not appear until a much later stage of growth. All in all I can see no justification for establishing a new genus for this species. Chao's specimens could well be juvenile forms, but they are no more than a more inflated form of *Procarinites* and in this respect differ from *kokeni* and *immaturus*.

Occurrence. *Subcolumbites* fauna, Naliling sections near Lolou village (Chao collections 541a, b, 542b), Kwangsi, China.

Family PARANANNITIDAE Spath, 1930

Genus *Arnautoceltites* Diener, 1916

Type species, *Celtites arnauticus* Arthaber, 1911

This genus is confined to the late Scythian *Prohungarites* Zone where it is represented by five species: *A. mediterraneus* from the *Subcolumbites* fauna of Albania and Chios, *A. bajaranasi* from the late Scythian strata of the Mangyshlak Peninsula, *A. involutus* from the *Subcolumbites* fauna of Kwangsi, China, *A. gracilis* from the *Subcolumbites* fauna of the Primorye Region, and *A. teichertii* from the *Subcolumbites* fauna of Nevada. Of special interest in this group of species is the very large degree of intraspecific variation in the Albanian and Chios *A. mediterraneus*, in contrast to a very limited degree of such variation in *A. teichertii* from Nevada. The other species are represented by very few specimens.

Arnautoceltites mediterraneus (Arthaber)

Plate 6, figures 7-13; Plate 7, figures 5, 6; Text-figure 14

Paranannites mediterraneus Arthaber, 1911: 220, pl. 18(2), fig. 8; Diener, 1915: 216; C. Renz, 1928: 155; Renz and Renz, 1947: 61, 66; Renz and Renz, 1948: 69, pl. 1, figs. 12, 12b, 13, 13a, 17.

Arnautoceltites mediterraneus,—Spath, 1934: 193, pl. 14, figs. 1a-c, text-fig. 59f.

Paranannites mediterraneus Arthaber var. *media* Renz and Renz 1947: 77; Renz and Renz, 1948: 70, pl. 1, figs. 11-11b, 14-14b.

Paranannites chionensis Renz and Renz, 1947: 66, 77; Renz and Renz, 1948: 70, pl. 1, figs. 10-10c.

Paranannites aspenensis Hyatt and Smith var. *europaea* Renz and Renz, 1947: 61; Renz and Renz, 1948: 71, pl. 1, figs. 16-16c.

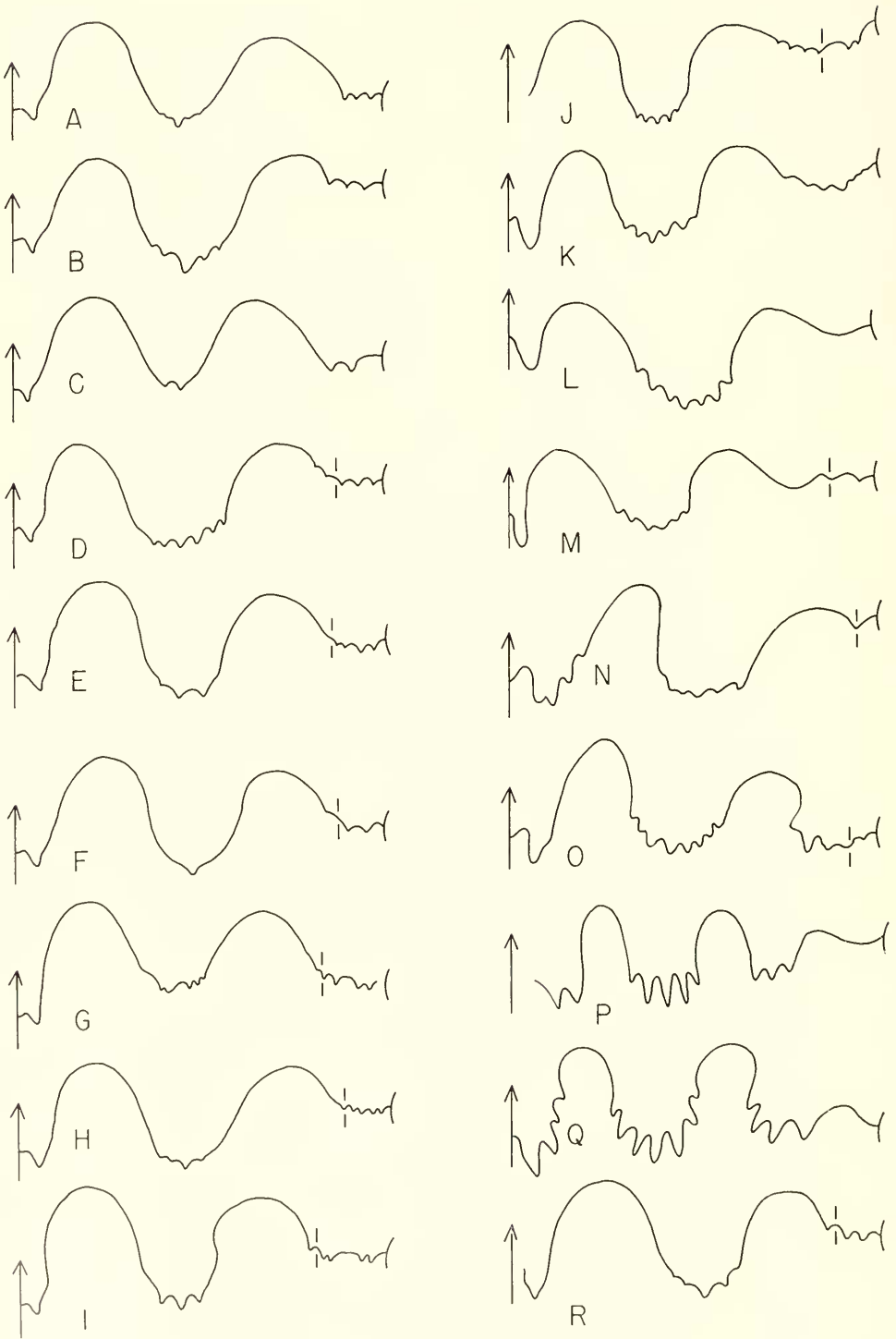
Paranannites compressus Renz and Renz, 1947: 61, 77 (non Smith, 1932: 99, pl. 31, figs. 19-20); Renz and Renz, 1948: 71, pl. 1, fig. 15-15b.

Paranannites chiosensis Kiparisova, 1961: 130 (= *P. compressus* Renz and Renz, 1948, non Smith, 1932).

Celtites arnauticus Arthaber, 1911: 267, pl. 24(8), fig. 7; Diener, 1915: 73; Smith, 1932: 37.

Arnautoceltites arnauticus,—Spath, 1934: 192, pl. 13, figs. 6a-f.

Paragoceras dukagini Arthaber, 1911: 182, 188, 265, pl. 24(8), fig. 6; Diener, 1915: 366; C. Renz, 1928: 155; Kutassy, 1933: 607; Spath,



1934: 199, fig. 60; Kummel, in Arkell, et al., 1957: L139, figs. 172, 3; Renz and Renz, 1948: 96.

Nannites herberti.—Arthaber (non Diener), 1908: 274, pl. 11(1), figs. 7a, b; Arthaber, 1911: 220.

A characteristic ammonite of the *Subcolumbites* fauna of Albania is a small form, generally involute, with prosiradiate constrictions. Arthaber (1908, 1911) classified ammonites of this general morphology in four species in four different genera. These species are:

Paranannites mediterraneus Arthaber

Celtites arnauticus Arthaber

Paragoceras dukagini Arthaber

Nannites herberti Diener

The first of the species was based on 5 specimens of which only 2 are preserved; the second species was based on 17 specimens of which only one exists; the last two species were each based on a single specimen and these are still preserved. The basic difference between these species as recognized by Arthaber lay in the suture. *Paranannites mediterraneus* was stated to have a single, serrated, lateral lobe, *Celtites arnauticus* a goniatitic lateral lobe, *Paragoceras dukagini* a particularly unique suture (of which more later), and finally, no suture was available on the specimen assigned to *Nannites herberti*.

The suture of the lectotype of *Paranannites mediterraneus* reproduced by Arthaber

(1911: pl. 18(2), fig. 8c) is somewhat poorly executed, but more significant, it is incomplete. A new drawing of the suture of this type specimen is reproduced here on Figure 14J. The principal new datum on the suture is the presence of a broad, shallow, second lateral lobe on the umbilical shoulder and wall.

The goniatitic suture of *Celtites arnauticus* needs verification. The only suture known of this species is that reproduced by Arthaber (1911: pl. 24(8), fig. 7d). It is only by implication that one would believe that this suture is from the figured specimen of Arthaber's plate 24(8), figures 7a–c. However, this specimen is preserved and shown here on Plate 6, figures 12, 13; no sutures are visible on the specimen. Likewise, Spath (1934: 192) did not uncover a suture among the topotypes in the British Museum, and resorted to reproducing Arthaber's data. The hard limestone preservation of the Albanian *Subcolumbites* fauna requires grinding and polishing to expose the suture. It has been demonstrated in this report that the sutures of many of the species described by Arthaber are to a greater or lesser extent distorted and inaccurate representations mainly due to excessive preparation. There is every reason to believe this is the case with the suture of *Celtites arnauticus*. This suggestion is strengthened on consideration of

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Figure 14. Diagrammatic representation of the sutures of various species of *Arnautoceltites*. A–I, *Arnautoceltites teichertii* n. sp., from Tobin Formation of Nevada; A, at a diameter of 11 mm (MCZ 9617); B, at a diameter of approximately 11 mm (MCZ 9618); C, at a diameter of 10.5 mm (MCZ 9619); D, at a diameter of 9.5 mm (MCZ 9620); E, at a diameter of 9 mm (MCZ 9621); F, at a diameter of 9 mm (MCZ 9622); G, at a diameter of 8.5 mm (MCZ 9623); H, at a diameter of 8.5 mm (MCZ 9624); I, at a diameter of 7 mm (MCZ 9625); J, lectotype of *Paranannites mediterraneus* Arthaber (1911), from *Subcolumbites* fauna, Albania; K, plesiotype of *Paranannites mediterraneus*,—Renz and Renz (1948: pl. 1, fig. 17), at a whorl height of approximately 9 mm, from *Subcolumbites* fauna of Chios (NHMB-J13729); L, syntype of *Paranannites mediterraneus* var. *media* Renz and Renz (1948: pl. 1, fig. 11b), at a diameter of approximately 20 mm, from *Subcolumbites* fauna of Chios (NHMB-J13732); M, holotype of *Paranannites chionensis* Renz and Renz (1948: pl. 1, fig. 10c), at a diameter of approximately 16 mm, from *Subcolumbites* fauna of Chios (NHMB-J13737); N, holotype of *Paranannites compressus* Renz and Renz (1948: pl. 1, fig. 15b), at a diameter of approximately 20 mm, from *Subcolumbites* fauna of Chios (NHMB-J13736); O, holotype of *Paranannites gracilis* Kiporisova (1961: fig. 93), at a diameter of approximately 10 mm; P, holotype of *Paranannites involutus* Choo (1959: fig. 37d), at a whorl height of 9 mm from beds with *Subcolumbites*, Kwangsi, China; Q, holotype of *Paranannites minutus* Choo (1959: fig. 37b), at a whorl height of 10.5 mm, from *Subcolumbites* fauna, Kwangsi, China; R, holotype of *Paragoceras dukagini* Arthaber (1911), at a diameter of approximately 11 mm, from *Subcolumbites* fauna, Albania.

the remaining morphological features of the shell. In this regard, the type specimen of *Celtites arnauticus* differs from the type specimen of *Paranannites mediterraneus* only in being slightly more evolute. It is unfortunate that the sample from the *Subcolumbites* fauna of Albania is so small, but Spath (1934: 192), in commenting on the few topotype specimens of *Celtites arnauticus* and *Paranannites mediterraneus* in the collections of the British Museum, states "there are thin and thick varieties of each." I cannot consider the differences in degree of involution of these two species (specimens) as a distinction warranting separation of the two forms.

The single specimen Arthaber (1908) assigned to *Nannites herberti* is illustrated here on Plate 6, figures 7, 8. It does not preserve a suture but in all other morphological features it is nearly identical to the specimen assigned to *Paranannites mediterraneus*.

Paragoceras dukagini (Arthaber, 1911: 265) was based on a single, poorly preserved specimen (Pl. 7, figs. 5, 6). The conch dimensions, degree of involution, and pattern of constrictions show the specimen to be identical with *A. mediterraneus*. It was primarily on the basis of the unusual suture reproduced by Arthaber (1911: pl. 24(8), fig. 6c) that Spath (1934) and others have accepted the genus. Re-examination of the type specimen shows that the suture has been damaged in preparation, but a new drawing of what is visible is shown on Figure 14R. The suture is that of a typical representation of *A. mediterraneus* and very unlike that reproduced by Arthaber.

The *Subcolumbites* fauna of Chios studied by Renz and Renz (1948) contains 19 specimens which they assigned to four species of *Paranannites* (= *Arnautoceltites*). Of these, however, only six of the figured specimens are sufficiently well preserved and complete to yield significant measurements, which are given on Table 29. Each of these specimens which yielded a suture

TABLE 29. MEASUREMENTS OF *ARNAUTOCELTITES MEDITERRANEUS* (ARTHABER) FROM THE *SUBCOLUMBITES* FAUNAS OF ALBANIA AND CHIOS.

	D	W	H	U	W/D	H/D	U/D
1.	26.1	9.5	10.9	7.6	36.4	41.8	29.1
2.	23.1	?	9.2	7.2	?	39.8	31.2
3.	23.0	7.0?	10.0	3.5	30.4?	43.5	15.2
4.	19.3	10.0	6.6	8.0	51.8	34.2	41.5
5.	18.5	11.0	6.6	6.4	59.5	35.7	34.6
6.	18.0	11.2	6.8	6.5	62.2	37.8	36.1
7.	17.4	11.2	7.0	5.0	64.4	40.2	28.7
8.	17.1	9.7	6.8	6.0	56.7	39.8	35.1
9.	16.5	?	6.4	4.9	?	38.8	29.7
10.	16.0	?	6.1	5.2	?	38.1	32.5
11.	15.6	?	7.3	3.7	?	46.8	23.7

1. Holotype, *Paranannites chionensis* Renz and Renz (1948, pl. 1, fig. 10), NHMB J13737.
2. Plesiotype, *P. mediterraneus* var. *media* Renz and Renz (1948, pl. 1, fig. 11), NHMB J13732.
3. Holotype, *Paranannites compressus* Renz and Renz (1948, pl. 1, fig. 15), NHMB J13736.
4. Lectotype, *Arnautoceltites arnauticus* (Arthaber, 1911, pl. 24(8), fig. 7).
5. Holotype, *Paragoceras dukagini* Arthaber (1911, pl. 24(8), fig. 6).
6. Plesiotype, *Paranannites mediterraneus*,—Renz and Renz (1948, pl. 1, fig. 12), NHMB J13727.
7. Lectotype, *Arnautoceltites mediterraneus* (Arthaber, 1911, pl. 18(2), fig. 8).
8. Plesiotype, *Nannites herberti*,—Arthaber (1908, p. 274, pl. 11(1), fig. 7) (non Diener).
9. Plesiotype, *P. mediterraneus* var. *media* Renz and Renz (1948, pl. 1, fig. 14), NHMB J13733.
10. Paralectotype, *Arnautoceltites mediterraneus* (Arthaber, 1911, p. 220).
11. Plesiotype, *P. aspenensis* var. *europaea* Renz and Renz (1948, pl. 1, fig. 16), NHMB J13735.

Specimens 1-3, 6, 9, 11 are from the *Subcolumbites* fauna of Chios; specimens 4, 5, 7, 8, 10 are from the *Subcolumbites* fauna of Albania.

has denticulated lobes. The specimens assigned to *Paranannites mediterraneus* (Renz and Renz, 1948: pl. 1, figs. 12, 13, 17), *Paranannites mediterraneus* var. *media* (Renz and Renz, 1948: pl. 1, figs. 11, 14), and *Paranannites aspenensis* Hyatt and Smith var. *europaea* (Renz and Renz, 1948: pl. 1, fig. 16) are clearly conspecific with the Albanian type specimen of *Arnautoceltites mediterraneus*. One highly compressed specimen was separated as *Paranannites compressus* (Renz and Renz, 1948: pl. 1, fig. 15) and another specimen intermediate in degree of compression between *compressus* and *mediterraneus* was set aside as *Paranannites chiosensis*. The sutures of these Chios specimens (Fig. 14M) are all essentially the same, differing in minor

details. The prosiradiate constrictions are variable in both the number per volution and in the degree of forward projection.

It is indeed unfortunate that the sample available from the *Subcolumbites* fauna of Chios is so limited. However, on the basis that these specimens came from one horizon and locality and were most probably part of a single population unit, and that other species of this population (for example *Isculitoides originis*) show a comparable range in shell variation as between *mediterraneus* and *compressus*, I believe it best to consider all these Chios specimens as members of a highly variable species—*mediterraneus*.

Occurrence. *Subcolumbites* fauna of Albania and Chios.

Repository. The following specimens from Albania are in the Paleontological Institute, University of Vienna: lectotype (Arthaber, 1908: pl. 18(2), fig. 8) and one paralectotype; lectotype of *Celtites arnauticus* Arthaber (1911: pl. 24(8), fig. 7); plesiotype of *Nannites herberti*,—Arthaber (1908: pl. 11, fig. 7) (non Diener); holotype of *Paragoceras dukagini* Arthaber (1911: pl. 24, fig. 6). In addition, the British Museum (Natural History) has some topotype specimens. The following specimens from Chios are in the Natural History Museum of Basel: plesiotype (Renz and Renz, 1948: pl. 1, fig. 12) NHMB J13727, (Renz and Renz, 1948: pl. 1, fig. 13) NHMB J13728, (Renz and Renz, 1948: pl. 1, fig. 17) NHMB J13729; *Paranannites mediterraneus* var. *media* (Renz and Renz, 1948: pl. 1, fig. 11) NHMB J13732, (Renz and Renz, 1948: pl. 1, fig. 14) NHMB J13733; unfigured specimen NHMB J13734; holotype *Paranannites chionensis* Renz and Renz (1948: pl. 1, fig. 10) NHMB J13737; unfigured paratype NHMB J13738; type of *Paranannites aspenensis* Hyatt and Smith var. *europaea* Renz and Renz (1948: pl. 1, fig. 16) NHMB J13735; holotype *Paranannites compressus* Renz and Renz (1948: pl. 1, fig. 15) NHMB J13736; specimen of *Paragoceras dukagini* Arthaber (Renz and

Renz, 1948: p. 96) NHMB J13838; topotypes from Chios MCZ 10115.

Arnautocellites bajarunasi (Astakhova)

Nannites bajarunasi Astakhova, 1960a: 145, pl. 34, figs. 2, 3; Astakhova, 1960b: 150.

This species has been based on two small specimens that morphologically are not too different in appearance from the Albanian *A. mediterraneus*. There appears to be a tendency on the outer volution for the whorls to be vaulted. The most significant characteristic is the goniatitic suture with a large, smooth lateral lobe followed by a much smaller lobe on the umbilical shoulder.

Occurrence. In *Stacheites* Zone of Astakhova (1960a, b) on the Mangyshlak Peninsula, said to be associated with *Stacheites prionoides*.

Arnautocellites involutus Chao

Text-figure 14

Paranannites involutus Chao, 1959: 113, 285, pl. 24, figs. 13–15, 18, 20, 25, text-fig. 37d.

Paranannites minutus Chao, 1959: 114, 286, pl. 24, figs. 16, 17, text-fig. 37b.

A very involute species most comparable to (and possibly conspecific with) *Paranannites gracilis* Kiparisova from the Primorye Region. The suture (Fig. 14P, Q) has a distinct second lateral lobe. Data on this species are very incomplete.

Occurrence. *Subcolumbites* fauna, Kwangsi, China (Chao collection 546).

Arnautocellites gracilis (Kiparisova)

Text-figure 14

Paranannites gracilis Kiparisova, 1947: 140, pl. 28, fig. 1, text-fig. 25; Kiparisova and Krishtofovich, 1954: 21, pl. 12, fig. 1; Kiparisova, 1961: 125, pl. 28, figs. 3, 4, text-figs. 92, 93.

Paranannites minor Kiparisova, 1961: 129, pl. 28, figs. 1, 2, text-fig. 98.

An involute species quite similar to *A. involutus* Chao and possibly even conspecific with it. The suture (Fig. 14O) is different in that the second lateral lobe occupies all of the umbilical shoulder and

TABLE 30. MEASUREMENTS OF *ARNAUTOCELTITES* *TEICHERTI* N. SP. FROM THE TOBIN FORMATION OF NEVADA.

	D	W	H	U	W/D	H/D	U/D
1.	21.3	12.1	8.2	6.2	56.8	38.4	29.1
2.	21.3	11.3	?	?	53.5	?	?
3.	20.2	12.1	8.7	4.8	59.4	43.0	23.2
4.	20.2	10.3	7.7	5.7	50.9	38.1	28.2
5	20.0	11.9	9.6	4.9	59.5	48.0	24.5
6.	19.7	12.4	7.7	5.9	62.9	39.0	29.9
7.	19.7	11.3	7.6	5.7	52.2	38.6	28.9
8.	19.6 ²	10.4	7.6	6.4	53.0 ²	38.7	32.6
9.	19.0	11.0	8.0	5.2	57.8	42.1	27.3
10.	18.8	11.2	8.0	5.0	59.5	42.5	26.5
11.	18.8	10.8	6.8	5.7	57.4	36.1	30.3
12.	18.1	9.6	7.3	5.3	53.0	40.3	29.2
13.	17.7	9.6	7.8	4.8	54.2	44.0	27.0
14.	17.5	11.7	7.4	3.8	66.8	42.2	21.7
15.	17.5	10.2	6.7	4.6	58.2	38.2	26.2
16.	16.5	9.2	6.6	4.3	55.7	40.0	26.6
17.	16.4	10.3	6.5	4.2	62.8	33.5	25.6
18.	16.2	9.5	6.7	4.3	58.6	41.3	26.5
19.	16.0	9.1 ²	7.1	4.0	56.8 ²	44.3	25.0
20.	15.6	9.4	6.7	4.1	60.2	42.9	26.2
21.	15.5	9.0	6.5	4.1	58.0	41.9	26.4
22.	15.3	9.0	6.5	4.1	58.8	42.4	26.7
23.	15.0	9.1	6.0	3.6	60.6	40.0	24.0
24.	14.8	9.3	6.0	3.6	63.5	40.5	24.3
25.	14.8	8.7	6.9	3.5 ²	56.0	46.6	23.6 ²
26.	14.6	9.0	5.4	3.7	61.6	36.9	25.3
27.	14.5	8.5	5.9	3.5	58.6	40.6	24.1
28.	14.4	8.2	6.1	3.1	56.9	42.3	21.5
29.	14.3	8.5	5.8	3.8	59.4	40.5	26.5
30.	14.1	9.4 ²	5.7	3.5	66.6 ²	40.4	24.8
31.	13.8	9.2	6.1	4.0	66.6	44.2	28.9
32.	13.3	8.8	5.7	3.3	66.1	42.8	24.8
33.	12.6	7.7	5.6	3.0	61.1	44.4	23.8
34.	11.1	7.6	4.6	3.0	68.4	41.4	27.0
35.	10.8	7.3	4.8	2.3	67.5	44.4	21.2
36.	9.6	6.5 ²	4.4	2.2	67.7	45.8 ²	22.9
37.	9.0	6.2	4.0	2.2	68.8	44.4	24.4
38.	8.4	6.4	4.2	1.2	76.1	50.0	14.2

3. Paratype, MCZ 9460 (Pl. 31, figs. 6, 7).
 4. Paratype, MCZ 9457 (Pl. 31, figs. 1, 2).
 7. Paratype, MCZ 9458 (Pl. 31, figs. 3, 4).
 8. Paratype, MCZ 9462 (Pl. 31, figs. 13, 14).
 9. Paratype, MCZ 9461 (Pl. 31, figs. 9, 10).
 12. Paratype, MCZ 9459 (Pl. 31, fig. 5).
 All other specimens are unfigured paratypes (MCZ 9490).

wall. Both this species and the Kwangsi *A. involutus* differ from *A. mediterraneus* and *A. teichert* in the suture and degree of involution of the conch.

Occurrence. *Subcolumbites* fauna, Cape Zhitkov, Primorye Region, Siberia.

Arnautoceltites teichert n. sp.

Plate 31, figures 1-7, 9-14; Text-figures 14, 15

The *Subcolumbites* fauna from the Tobin Formation of Nevada has yielded approximately 75 specimens of this new species, of which 38 are sufficiently well preserved and complete to obtain measurements. The measurements are given on Table 30 and the plot of these data shown on the graph of Figure 15.

The basic morphology of the shell, that is, degree of involution, whorl cross-section, pattern of constrictions, etc., is very much like that of the Albanian *Arnautoceltites mediterraneus*. It is only in the suture that a small but subtle difference between these species can be recognized. On Figure 14 are 9 sutures of *A. teichert*. It is readily seen that there is a high degree of variability. This is especially noted in the shape and pattern of denticulation of the first lateral lobe. The second lateral lobe, lying on the umbilical shoulder and wall, is likewise variable but in all cases more pronounced than in the Albanian and Chios representations of *A. mediterraneus*. It is primarily on this feature that I conclude the two species are specifically distinct but closely related. These two species are quite distinct from the other species of *Arnautoceltites* so far recorded.

Occurrence. Lower part Tobin Formation, U.S.G.S. Mesozoic locality M2562, Pershing County, Nevada; south tip of Tobin Range, Cain Mountain 1:62,500 quad., center NW ¼ sec. 9, T. 26N, R. 39E, 5,500 ft. S, 27.5 ft. W from elevation point 5088 on range crest.

Repository. Holotype, MCZ 9457 (Pl. 31, figs. 1, 2); paratypes, MCZ 9458 (Pl. 31, figs. 3, 4), MCZ 9459 (Pl. 31, fig. 5), MCZ 9460 (Pl. 31, figs. 6, 7), MCZ 9461 (Pl. 31, figs. 9, 10), MCZ 9462 (Pl. 31, figs. 13, 14); suture specimens Figures 31A-I, MCZ 9617-9625; unfigured paratypes MCZ 9490.

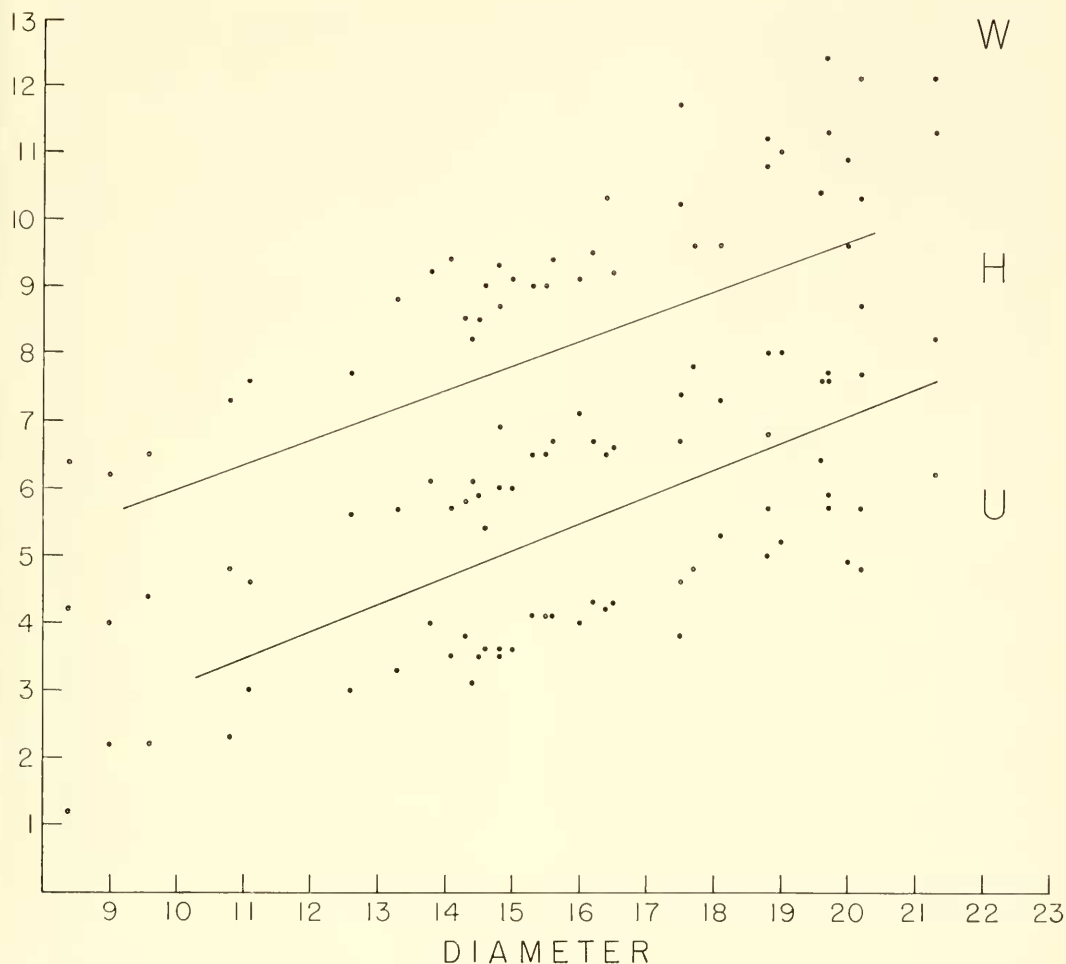


Figure 15. Variation in whorl height (H), whorl width (W) and umbilical diameter (U) in *Arnautocellites teichertii* n. sp. from the Tobin Formation of Nevada. The data on this graph are from Table 30.

Genus *Prosphingites* Mojsisovics, 1886

Type species, *Prosphingites czekanowskii* Mojsisovics, 1886

Prosphingites has until the last few years been considered mainly a late Scythian genus (*Subcolumbites*—*Prohungarites* Zone). The type species, *P. czekanowskii* Mojsisovics (1886: 64, pl. 15, figs. 10–12) came from the *Olenekites* fauna of northern Siberia, of upper Scythian age. Hyatt and Smith (1905: 72, pl. 7, figs. 1–4) later described *P. austini* from the *Meekoceras* fauna of southern California. Spath (1934)

was uncertain as to the status of *P. austini* and in his interpretation of the zonal range of the genus tended to place more reliance on the type species from the Olenek beds and *P. spathi* (Frebold, 1930) from the so-called Fish beds of Spitsbergen, which he considered to be late Scythian in age, more or less contemporaneous with the Olenek fauna. Both Kummel (1961) and Tozer (1961a) have presented convincing arguments that this particular Spitsbergen horizon is mid-Scythian (*Owenites* Zone) in age. In recent years a number of new

species of *Prosphingites* have been described from Chios (Renz and Renz, 1948), Kwangsi, China (Chao, 1959), eastern Siberia (Kiparisova, 1961), Arctic Canada (Tozer, 1961a), and western United States (Kummel and Steele, 1962).

From the mid-Scythian, *Owenites* Zone, the following species of *Prosphingites* are known: *Prosphingites austini* Hyatt and Smith, *P. ovalis* Kiparisova, *P. orientalis* Kiparisova, *P. sinensis* Chao, *P. involutus* Chao, *P. kwangsiensis* Chao, *P. radians* Chao, *P. spathi* Frebold, *P. slossi* Kummel and Steele. The documentation and illustration of all these species from essentially contemporaneous deposits in western United States, Arctic Canada, Spitsbergen, eastern Siberia, and southern China has added much to our understanding of *Prosphingites* during the mid-Scythian. When I introduced the species *P. slossi* (Kummel and Steele, 1962) I was fully cognizant of its close relationship and perhaps identity to *P. austini* Hyatt and Smith; however, on the argument that *P. austini* was known only from a single, not very well preserved specimen, I considered it best to ignore the species. However, subsequently, on study of all the new Scythian species that have been introduced, and thorough restudy of *P. austini*, I am convinced that *P. ovalis*, *P. orientalis*, *P. sinensis*, *P. radians*, *P. spathi*, and *P. slossi* are synonyms of *P. austini*. Large populations of these species are known only for *P. spathi* and *P. slossi*. Large numbers of specimens of *P. spathi* are in the British Museum (Natural History), but only a few measurements are available. Nearly all the Spitsbergen specimens are small phragmocones or juvenile specimens.

Kummel and Steele (1962: 683) have presented measurements on 49 specimens of *P. slossi* from the *Meekoceras* beds at Crittenden Spring, Nevada. A plot of the available measurements of the other species of *Prosphingites* shows them to fall within the limits of variations for *P. slossi*. The Nevada fauna likewise shows that the pat-

tern of constrictions is highly variable. Evaluation of the suture in all these species is more difficult, as generally only one pattern is given for any species by most authors. However, on the basis of the variability in suture within the Crittenden Spring fauna and within *P. spathi* from the Canadian Arctic described by Tozer (1961d), I believe that the pattern for all the various species placed in the synonymy of *P. austini* is essentially the same, and what variation is present is partly due to the small size of the sample (generally one suture per species) and, more fundamentally, is no more than one should expect. The suture of these mid-Scythian species of the *Owenites* Zone is in general simpler than for species in higher Scythian zones. This is especially marked in the nature of the ventral lobe and in the auxiliary lobe (Fig. 16).

No species of *Prosphingites* are known from the *Columbites* Zone. The following species have been described from the upper Scythian *Subcolumbites*-*Olenekites* fauna: *Prosphingites czekanowskii* Mojsisovics, *P. globosus* Kiparisova, *P. insularis* Kiparisova, *P. lolouensis* Chao, *P. ali* Arthaber, *P. vonderschmitti* Renz and Renz, and *P. coombsi* Kummel.

Prosphingites czekanowskii is unique in its compressed living chamber and acute venter, but the suture is relatively simple (Fig. 16G, H) and not unlike that of species in the *Owenites* Zone. *Prosphingites globosus* is based on a few, very small, immature specimens and is too incompletely known to make meaningful comparisons; the same can be said for *P. ali*, but in each case the suture is of an advanced type with a more distinct auxiliary lobe and more elaborate ventral lobe (Fig. 16D-F). *Prosphingites lolouensis* is based on a few poorly preserved specimens. *Isculitoides globosus* Chao (1959: 292, pl. 26, figs. 9-13) appears to be a synonym of *P. lolouensis* Chao. *Prosphingites vonderschmitti* from the *Subcolumbites* fauna of Chios is a species of *Zenoites*.

Thus, there are now 16 described species of *Prosphingites*. Analysis of the nine species described from the mid-Scythian *Owenites* Zone leads me to accept only four of these as valid; the remaining five are synonyms. The valid species are: *P. austini*, known from western United States, Ellesmere Island, Spitsbergen, Primorye Region, and Kwangsi; *P. involutus* Chao, an incompletely known species from Kwangsi, China; *P. kwangsiensis* Chao, another incompletely known species from Kwangsi; *P. magnumbilicatus* Kiparisova, presumably from the *Prosphingites* Zone (= *Owenites* Zone) of the Primorye Region. All of the species from the upper Scythian *Subcolumbites* Zone are believed to be valid except *P. vonderschmitti* Renz and Renz, which is a species of *Zenoites*.

The principal difference between most of these species of *Prosphingites* of the upper Scythian and those of the mid-Scythian lies in the suture. The species from the upper Scythian tend to have sutures with phylloid saddles, more elaborate denticulation of the lobes, and a distinct auxiliary lobe.

***Prosphingites czekanowskii* Mojsisovics**
Plate 26, figure 8; Text-figure 16

Prosphingites czekanowskii Mojsisovics, 1886: 64, pl. 15, figs. 10–12; Noetling, in Frech, 1905: 200, pl. 28, fig. 8; Diener, 1915: 233; Spath, 1934: 33, 195, 196; Kiparisova, 1937: 140, pl. 1, fig. 2; Kiparisova, 1947: 142, pl. 32, figs. 4, 5, text-fig. 28; Kummel, 1961: 522; Popov, 1961: 58, pl. 13, fig. 4.

Prosphingites cf. *P. czekanowskii*,—Tozer, 1965a: 19, pl. 2, figs. 5a–c, text-fig. 3.

This very characteristic and almost unique type species is known from relatively few specimens. In the two main discussions of the species by Mojsisovics (1886) and Popov (1961) it appears there were only a total of five specimens. One topotype specimen is now in the Museum of Comparative Zoology. The major features of the species are the globose, depressed inner whorls grading adorally to more compressed whorls, and a sharpening

of the venter. The suture is shown on Figures 6G, H. I include within this species the specimen Tozer (1965a) records from British Columbia. Even though this specimen is partially crushed, the visible conch features and the suture indicate this identification.

This species is unique in that in no other species assigned to *Prosphingites* does the venter become acute. In the suture, also, this species differs from most other species of *Prosphingites* from the upper Scythian in the reduced character of the auxiliary lobe. In this aspect it is more comparable to the suture found in species of *Prosphingites* from the *Owenites* Zone. There is also no development of phylloid saddles such as characterize *P. globosus*, *P. insularis* and *P. coombsi*, all of late Scythian age.

Occurrence. *Olenekites* fauna, northern Siberia, and Toad Formation, Halfway River area, British Columbia.

Repository. The Museum of Comparative Zoology has one topotype specimen (8677).

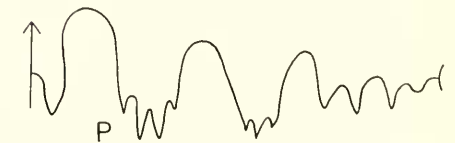
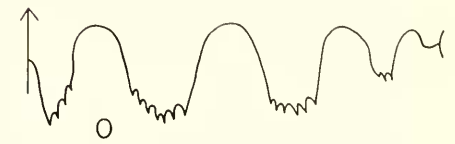
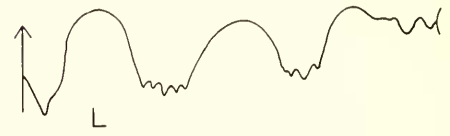
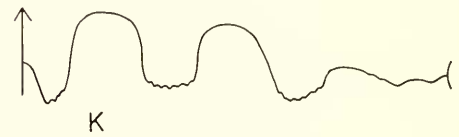
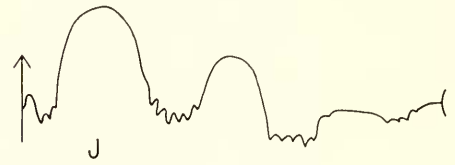
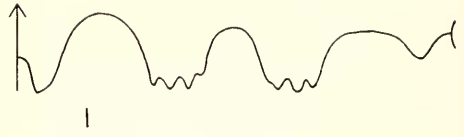
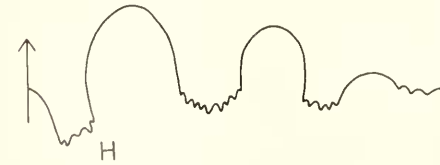
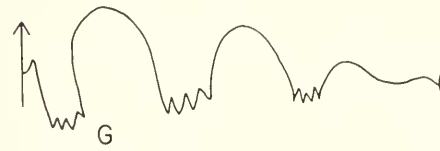
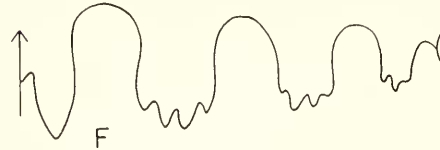
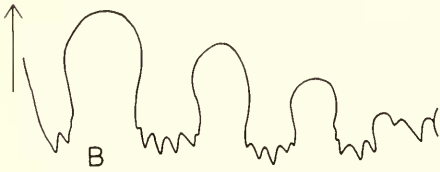
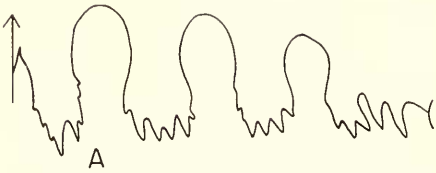
***Prosphingites ali* Arthaber**

Plate 20, figures 12, 13; Text-figure 16

Prosphingites ali Arthaber, 1911: 252, pl. 22(6), figs. 6, 7; Diener, 1915: 233; Spath, 1934: 189, fig. 59g.

Arthaber (1911: 252) states he had three specimens of this species but only the specimen he illustrated is preserved. The dimensions of this specimen are as follows: Diameter 15.3, Width 10.2, Height 6.0, Umbilicus 4.7 mm. The specimen preserves much of the shell but this has been polished and is perfectly smooth. This specimen likewise does not show any trace of a suture; it is presumed that the suture Arthaber figured (1911, pl. 22(6), fig. 6c; Fig. 16F of this report) came from one of the other two specimens he had in his original collection.

This species was based on what are obviously juvenile forms, making comparisons with other species of the genus tenuous at best. It is of special interest that the closely



related *Subcolumbites* fauna of Chios does not contain any true *Prosphingites*. The specimen described by Renz and Renz (1948: 39, pl. 15, figs. 13, 15) as *Prosphingites vonderschmitti* is a species of *Zenoites*; the specimen they assigned to *Prosphingites* ex aff. *czekanowskii* is a representative of *Zenoites helenae* Renz and Renz.

Occurrence. *Subcolumbites* fauna, Kçira, Albania.

Repository. The holotype is in the Paleontological Institute, Vienna.

Prosphingites lolouensis Chao

Prosphingites lolouensis Chao, 1959: 123, 298, pl. 27, figs. 18–24, text-fig. 39b.

Isculitoides globosus Chao, 1959: 119, 292, pl. 26, figs. 9–13.

This is a most unsatisfactory species group. *Prosphingites lolouensis* was established for a “great number” of deformed specimens that never should have been given a new specific name. The specimens assigned by Chao (1959) to *Isculitoides globosus* have a prosphingitid suture, as noted by Chao (1959: 293), but he distinguished it on differences in the nature of the umbilical shoulders. Even considering the state of preservation of the Kwangsi material, I cannot separate these specimens from those assigned to *P. lolouensis*.

Occurrence. *Subcolumbites* fauna of

Chashanao sections (Chao collection 610) and northeast of Lolou village (Chao collection 541a, b), Kwangsi, China.

Prosphingites subglobosus (Chao)

Paranannites subglobosus Chao, 1959: 113, 285, pl. 24, figs. 21–24, text-fig. 37a.

The most distinctive aspect of this species is the eccentricity of the umbilicus on the last volution. In this respect this species is quite different from all others assigned to *Prosphingites*. The suture is quite like that of the type species *P. czekanowskii* with a weakly developed auxiliary series.

Occurrence. *Subcolumbites* fauna, Naliling section (Chao collections 542a, b), Kwangsi, China.

Prosphingites globosus Kiparisova

Text-figure 16

Prosphingites globosus Kiparisova, 1947: 142, pl. 32, figs. 6, 7, text-fig. 29; Kiparisova and Krish-tofovich, 1954: 21, pl. 12, figs. 2, 3; Kummel, 1961: 523; Kiparisova, 1961: 108, pl. 25, figs. 1, 2, text-figs. 69, 70.

Prosphingites aff. *globosus* Kiparisova, 1961: 109, pl. 25, fig. 3, text-fig. 71.

A species based on two specimens, one of which is a very small juvenile. Main features are a very depressed whorl section with an involute conch and showing the beginnings of eccentricity of the umbilicus. The suture (Fig. 16D, E) is characterized

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Figure 16. Diagrammatic representation of the sutures of several species of *Prosphingites*. Sutures A–G are of species from the upper Scythian *Subcolumbites* Zone, sutures I–P are of species from the mid-Scythian *Owenites* Zone. A, *P. coombsi* Kummel, paratype [OU3861], at a diameter of 21 mm, from near Kaka Point, New Zealand; B, *P. coombsi* Kummel, paratype [OU3863], at a diameter of 20 mm; C, *P. insularis* Kiparisova (1961: fig. 74), at a whorl height of 9 mm from *Subcolumbites* fauna, Primorye Region; D, *P. globosus* Kiparisova (1961: fig. 69), at a whorl height of 3 mm, from *Subcolumbites* fauna, Primorye Region; E, *P. globosus* Kiparisova (1961: fig. 70), holotype, at a whorl height of 7 mm, from *Subcolumbites* fauna, Primorye Region; F, *P. ali* Arthaber (1911: pl. 22, fig. 6c), from *Subcolumbites* beds Kçira, Albania; G, *P. czekanowskii* Majsisovics (1886: pl. 15, fig. 11c), from *Olenekites* fauna, Olenek River, Siberia; H, *P. czekanowskii* Majsisovics, topotype (MCZ 8677), at a diameter of 31 mm; I, *P. austini* Hyatt and Smith (1905: pl. 7, fig. 4), from *Meekoceras* fauna, Union Wash, Inya Range, California (USNM 75256), at a diameter of 20 mm; J, *P. slassi* Kummel and Steele, paratype, at a diameter of 18 mm from *Meekoceras* fauna, Crittenden Spring, Nevada; K, *P. slassi* Kummel and Steele (1961: text-fig. 15a), at a diameter of 30 mm, from *Meekoceras* fauna, Crittenden Spring, Nevada; L, *P. spathi* Frebold,–Tozer (1961: pl. 13, fig. 1c), at a diameter of 16 mm, from *Meekoceras* fauna, Blind Fiord Formation, Ellesmere Island; M, *P. aialis* Kiparisova (1961: fig. 79), at a whorl height of 5 mm, from *Prosphingites* Zone, Primorye Region; N, *P. involutus* Chao (1959: pl. 28, fig. 9), from *Owenites* Zone, Kwangsi, China; O, *P. kwangsiensis* Chao (1959: text-fig. 39d), from *Owenites* fauna, Kwangsi, China.

by slightly phylloid saddles and a well developed auxiliary lobe.

It is inescapable that perhaps both of the specimens of this species are juvenile forms. Until more material becomes available an assessment of this species is most difficult. The whorl section is more depressed than in any other species of *Prosphingites* recorded to date, and it is this feature which can be looked upon as the most distinguishing for the species.

Occurrence. *Subcolumbites* fauna, Russian Island, Cape Zhitkov, Primorye Region, eastern Siberia.

Prosphingites insularis Kiparisova

Text-figure 16

Prosphingites insularis Kiparisova, 1961: 112, pl. 24, figs. 2-4, 6, text-figs. 74-76.

Prosphingites aff. *insularis* Kiparisova, 1961: 114, pl. 24, fig. 5, text-fig. 77.

Prosphingites magnumbilicatus Kiparisova, 1961: 114, pl. 25, fig. 4, text-fig. 78.

A more evolute prosphingitid with depressed rounded whorls and a broad deep umbilicus. Its most characteristic feature is the suture with well denticulated lobes and phylloid saddles (Fig. 16C). In its external conch features this species is nearly identical with *P. coombsi* Kummel (1965); it is only in the dorsal suture that differences can readily be seen. This species has adjacent to the dorsal lobe two lateral lobes whereas in *P. coombsi* there are four. It differs both in conch shape and suture from *P. ezekanowskii*. It differs from *P. globosus* mainly in conch shape and involution.

Occurrence. *Subcolumbites* fauna, Primorye Region, Siberia.

Prosphingites coombsi Kummel

Text-figure 16

Prosphingites coombsi Kummel, 1965: 538, figs. 1-5.

This species, in its general conch architecture, is nearly identical to *P. insularis* Kiparisova. It differs mainly in a more elaborate dorsal suture (Fig. 16A, B).

Occurrence. This species was established for specimens encountered in an isolated pocket within disturbed beds between Kaka Point and Nugget Point, south Otago, New Zealand. On the basis of the general morphology of the species, I have (Kummel, 1965) interpreted this horizon as late Seythian in age comparable to the horizon of *Subcolumbites* of the Tethyan and circum-Pacific region.

Repository. Department of Geology, Otago University, New Zealand. Four paratypes are in the Museum of Comparative Zoology (MCZ 10113).

Genus *Vickohlerites* Kummel, 1968

Type species, *Prenkites sundaicus* Welter, 1922

Vickohlerites sundaicus (Welter)

Prenkites sundaicus Welter, 1922: 150, pl. 168(4), figs. 18-21; Kutassy, 1933: 621; C. Renz, 1945: 301; Renz and Renz, 1947: 60; Renz and Renz, 1948: 29, pl. 12, fig. 1; Chao, 1959: 306.

"*Prenkites*" *sundaicus*,—Spath, 1930: 77; Spath, 1934: 188, 209.

Vickohlerites sundaicus,—Kummel, 1968a: 9, pl. 1, figs. 10, 11.

Welter (1922) described this species on the basis of a single specimen from Noel Niti, Timor, and was quite positive as to the close relationship of his specimen to *Prenkites malsorensis* Arthaber from the *Subcolumbites* fauna of Albania. This close relationship is difficult to see. *Prenkites* is a more involute form, with depressed whorls which contract on the adoral quarter revolution. The umbilical shoulders are subangular and bear fine nodes. The Timor specimen has a diameter of 40.7 mm, an adoral whorl width of 21.5 mm, a height of the adoral whorl of 13.2 mm and an umbilical diameter of 20.3 mm. The conch is evolute, the umbilicus comprising approximately 50 percent of the conch diameter. The whorls are depressed with the maximum width at the umbilical shoulder. The venter is arched and grades with no perceptible ventral shoulders to the umbilical shoulder which is acutely rounded. The umbilical wall is steep but not vertical.

The last half volution of the specimens is body chamber and shows traces of delicate growth lines. The penultimate half volution bears a series of weak, forward projecting ridges which are most prominent on the center part of the venter and disappear completely midway between the venter and the umbilical shoulder.

It is in Welter's (1922, pl. 14, fig. 21) representation of the suture that one can pinpoint the uncertainty in interpretation of this form. Welter's drawing of the suture covers only the portion from the venter to the umbilical shoulder, but the drawing implies that it was a complete suture. A new drawing of the suture is given in Kummel (1968, fig. 1J). There are two prominent lateral lobes but the umbilical wall bears a good portion of a fairly large auxiliary saddle and a small but very distinct denticulated lateral lobe. The first author after Welter to comment on *Prenkites sundaicus* was Spath (1930, p. 77) who wrote, "*Prenkites' sundaicus* Welter, in whorl shape resembles *Columbites*, but in suture line it is closer to *Subcolumbites*. . . ." In terms of Welter's representation of the suture this statement is correct. In *Columbites* the second lateral lobe is generally very small, consisting of a single prong, whereas in *Subcolumbites* the second lateral lobe, though much smaller than the first, is more highly developed in terms of its breadth and pattern of denticulation. On the basis of suture alone, *Prenkites sundaicus* can not be attached to either *Columbites* or *Subcolumbites*.

There is a general similarity in conch shape of *Prenkites sundaicus* with some groups of *Subcolumbites*. Among the subcolumbitids three distinct groups can be recognized. There is first of all the *perinismithi* group with a tendency for carination of the venter; secondly the *dusmani* group with a more marked development of the reticulate ornamentation, a compressed whorl section, but lacking the tendency toward carination; finally there is the *robustus-multiformis* group charac-

terized mainly by their depressed whorl section. It is to this last group that *Vickohlerites sundaicus* has great resemblance in conch form. Within the two subfamilies of the Paranannitidae those genera assigned to the Columbinae tend to have sutures lacking an auxiliary lobe, whereas within the Paranannitinae an auxiliary lobe is commonplace, as in *Prosphingites*, *Zenoites*, *Chiotites*, etc. It is within this subfamily that *Vickohlerites sundaicus* belongs.

Renz and Renz (1948: 24, pl. 12, fig. 1) have described and illustrated a single specimen from the *Subcolumbites* fauna of Chios as a representative of this species. The general conch form of their specimen is the same as that of the type specimens from Timor. This Chios specimen measures 55.5 mm in diameter, 21.4 mm for the width of the adoral whorl, 19 mm for the height, and 23.5 mm for the width of the umbilicus. The dimensions of the whorl height and umbilical diameter in the two specimens are reasonably similar. However, the Timor specimen has a broader whorl than the Chios specimen by approximately 14 percent. This difference in whorl width is difficult to evaluate, as each locality has yielded only a single specimen. In addition, the Chios specimen, apparently, does not show the suture. The overall similarity of the Chios specimen to that from Timor is such that, in spite of the differences and lack of data mentioned above, the two specimens should be considered as conspecific.

The new specimen recorded by Kummel (1968) as *Vickohlerites* cf. *sundaicus* from a *Subcolumbites* fauna at Kotal-e-Tera, Afghanistan, is clearly congeneric with the Timor and Chios specimens discussed above but is not conspecific. Critical comparison of the Afghan and Timor forms is difficult, as each is represented by a single specimen. There is an overall similarity between the two specimens, but at the same time there are intriguing differences in whorl shape and suture.

Occurrence. The holotype is from Noel

Niti, Timor. Welter (1922: 85, 86) considered this specimen to come from his lowest Triassic horizon. The forms associated with this specimen he lists on page 150 as *Meekoceras* sp. indet. The available evidence does not allow any precise determination of the age, but the biological affinities of this species suggest that it is late Scythian in age. The specimen recorded by Renz and Renz (1948) is from the *Subcolumbites* fauna of Chios.

Repository. The holotype is in the Paleontological Institute of Bonn University; the specimen from Chios is in the Natural History Museum, Basel J13576.

Genus *Zenoites* Renz and Renz, 1947

Type species, *Prospingites* (*Zenoites*) *helenae* Renz and Renz, 1947

Generally small, somewhat evolute form with rounded, depressed whorl sections bearing irregularly spaced radial to prosiradiate constrictions that encircle the whorl section; suture consists of two denticulated lateral lobes, one auxiliary lobe on the umbilical shoulder and the appearance of another lobe on the umbilical seam.

The suture and general shape of the conch indicate a relationship to *Prospingites*. This genus was first recognized from the *Subcolumbites* fauna of Chios by Renz and Renz (1948). Since then it has been recognized from a late Scythian horizon on Ellesmere Island (Tozer, 1965a).

Zenoites helenae Renz and Renz

Text-figure 17

Prospingites (*Zenoites*) *helenae* Renz and Renz, 1947: 60, 75; Renz and Renz, 1948: 41, pl. 15, figs. 8–8a, pl. 16, figs. 1–1c.

Prospingites (*Zenoites*) *helenae* var. *maradovunensis* Renz and Renz, 1947: 60, 75; Renz and Renz, 1948: 42, pl. 15, figs. 12–12a, 14–14a. *Zenoites helenae*.—Kummel, in Arkell et al., 1957: L139, figs. 172, 4.

Prospingites ex aff. *czekanowskii*.—Renz and Renz, 1948: 39, pl. 15, figs. 11–11b.

The variety established for this species (*maradovunensis*) consists merely of two slightly more compressed forms. The mea-

surements of the figured specimens are as follows:

	D	W	H	U	W/D	H/D	U/D
1.	24.0	13.4	8.7	9.4	55.8	36.3	39.2
2.	17.4	?	5.3	6.5	?	30.5	37.4
3.	21.6	10.2	7.2	9.3	47.2	33.3	43.1
4.	17.7	9.0	6.4	6.1	50.8	36.2	34.5

1. Holotype, NHMB J13648, Renz and Renz, 1948: pl. 16, fig. 1.

2. Paratype, NHMB J13649, Renz and Renz, 1948: pl. 15, fig. 8.

3. var. *maradovunensis*, NHMB J13652, Renz and Renz, 1948: pl. 15, fig. 14.

4. var. *maradovunensis*, NHMB J13651, Renz and Renz, 1948: pl. 15, fig. 12.

This species is not common in the Chios fauna; Renz and Renz record only five specimens, and there are 9 additional specimens in the Natural History Museum, Basel. The suture is shown on Figure 17A.

Occurrence. *Subcolumbites* fauna, Maradovuno, Chios.

Repository. Holotype, NHMB J13648; figured paratypes NHMB J13649, J13651, J13652; unfigured paratypes NHMB J13650.

Zenoites vonderschmitti (Renz and Renz)

Text-figure 17

Prospingites vonderschmitti Renz and Renz, 1947: 60, 74; Renz and Renz, 1948: 39, pl. 15, figs. 13, 15.

This is a highly compressed form in comparison to the genotype *helenae*. The holotype (Renz and Renz, 1948: pl. 15, fig. 13) measures 24.6 mm in diameter, 9.5 mm for the width of the adoral whorl, 7.3 mm for the height, and 10.8 mm for the diameter of the umbilicus. The paratype (Renz and Renz, 1948: pl. 15, fig. 15) measures 15.7 mm in diameter, 5.2 mm for the height of the adoral whorl and 7.1 mm for the diameter of the umbilicus (faulty preservation prevents obtaining a whorl width measurement). Aside from the very different whorl dimensions, this species has a different pattern of constriction. The suture, however, (Fig. 17B) is almost identical in these two Chios species.

Occurrence. *Subcolumbites* fauna, Chios.

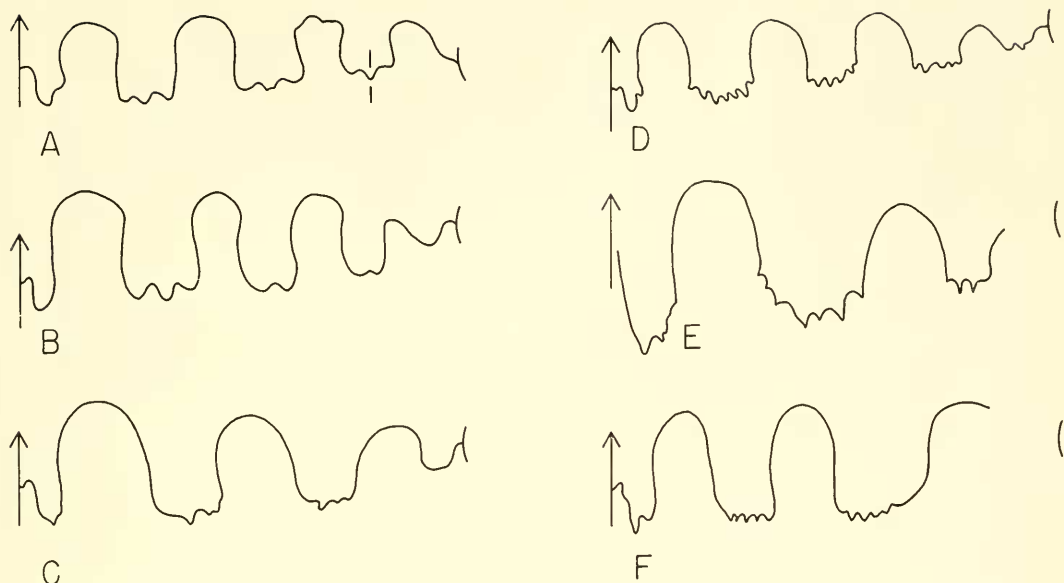


Figure 17. Diagrammatic representation of the suture of: A, holotype *Zenoites helenae* Renz and Renz (1948: pl. 16, fig. 1c), at a diameter of approximately 18 mm; B, holotype of *Prosphingites vanderschmitti* Renz and Renz (1948: pl. 15, fig. 13c), at a diameter of approximately 18 mm; C, paratype *Calumbites huangi* Chao (1959: pl. 29, fig. 11), at a diameter of approximately 20 mm; D, paratype *Chiotites glabularis* Renz and Renz (1948: pl. 15, fig. 9c), at a diameter of approximately 15 mm; E, paratype *Popovites occidentalis* Tazer (1965: fig. 5b), at a diameter of approximately 30 mm; F, paratype *Manacanthites monaceras* Tazer (1965: fig. 8), at a diameter of approximately 15 mm.

Specimens of figures A, B, C from *Subcalumbites* fauna of Chios; D, E from Taad Formation, British Columbia; F, from upper Scythian of Ellesmere Island.

Repository. Holotype NHMB J13639 (Renz and Renz, 1948: pl. 15, fig. 13); paratype NHMB J13640 (Renz and Renz, 1948: pl. 15, fig. 15); unfigured paratypes NHMB J13641.

Zenoites arcticus Tozer

Zenoites arcticus Tozer, 1965a: 25, pl. 2, figs. 6, 7, text-fig. 7.

Only two specimens of this species are known. It differs from *Z. helenae* mainly in the pattern of constriction.

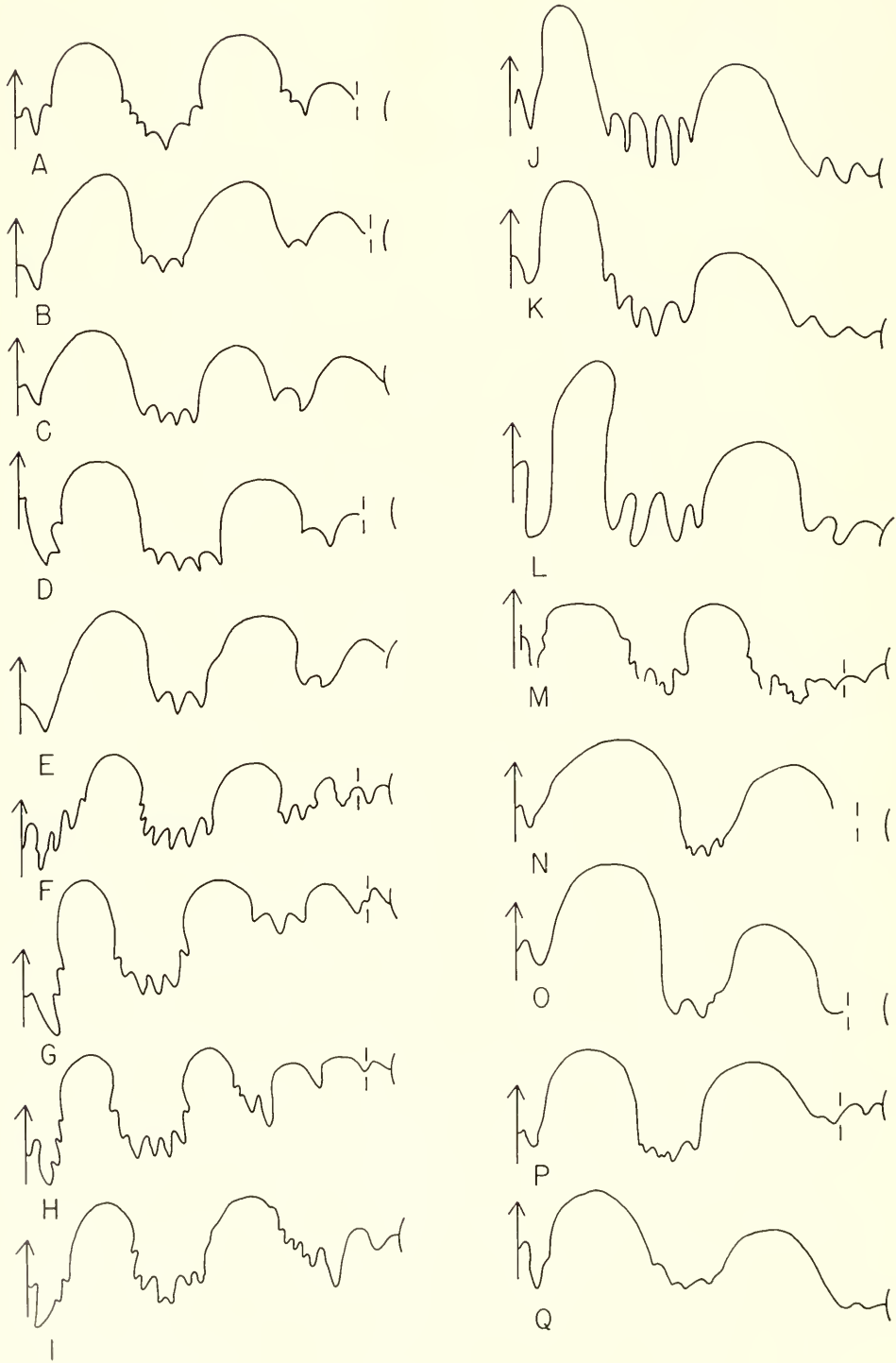
Occurrence. Blaa Mountain Formation, lower shale member, Ellesmere Island.

Genus *Isculitoides* Spath, 1930

Type species, *Isculites originis* Arthaber, 1911

This is another of the genera which are confined to the late Scythian *Prohungarites*

Zone, where it is represented by six species. In the *Subcalumbites* fauna of Albania and Chios, *I. originis* is one of the most common species. This species in the Chios fauna shows a very large degree of intraspecific variation. *Isculitoides ellipticus* from Kwangsi, China, *I. minor* from British Columbia, and *I. suboviformis* from the Priorye Region are represented by very few specimens. Additional collections of these three species are badly needed to clarify their relationships. In the western United States we have *I. wasserbergi* and *I. hammondi*, both species known from a fair number of specimens. Specimens assigned to *Isculitoides* cf. *originis* have been recorded from the *Subcalumbites* fauna at Kotal-e-Tera, Afghanistan (Kummel, 1968b) and specimens of indeterminate specific identity from the *Prohungarites* fauna of the Salt Range, West Pakistan.



Isculitoides originis (Arthaber)

Plate 5, figures 1–10; Plate 6, figures 1–6; Text-figures 18–20

Isculites originis Arthaber, 1911: 259, pl. 23(7), figs. 1–10; Diener, 1915: 157; C. Renz, 1928: 155; Kutassy, 1933: 540; Renz and Renz, 1947: 60; Renz and Renz, 1948: 33, pl. 13, figs. 7–7a, 9–9a, 11–11b, 12–12b, pl. 14, figs. 6–6a, 9–9a.

Isculitoides originis,—Spath, 1934: 198, pl. 14, figs. 2a–d, text-fig. 59b, c.

Isculites globulus Renz and Renz, 1947: 60, 74; Renz and Renz, 1948: 34, pl. 14, figs. 10–10c, 4–4a, 5–5a, 8–8b, 11–11b.

Isculites antiglobulus Renz and Renz, 1947: 60, 74; Renz and Renz, 1948: 35, pl. 13, figs. 1–1a, 10–10a, pl. 13, figs. 2–2a, 3–3a, 5–5a, 8–8a.

Isculites globulus-originis Renz and Renz, 1947: 60; Renz and Renz, 1948: 35, pl. 13, figs. 6–6a, pl. 14, figs. 1–1a, 2–2a, 3–3a.

Isculites globulus-antiglobulus Renz and Renz, 1947: 60; Renz and Renz, 1948: 35, pl. 13, figs. 4–4a, pl. 14, figs. 7–7a.

Arthaber (1911: 259) stated he had 54 specimens of this species, 10 of which he illustrated. The type specimen and seven paratypes, all among those illustrated by Arthaber (1911), are still preserved. The preservation of all these specimens leaves much to be desired and most are too badly preserved or incomplete to yield significant measurements. Arthaber's (1911: pl. 23(7), figs. 1–10) illustrations are highly retouched and idealized; unretouched photographs of the existing original specimens are reproduced here on Plates 5 and 6.

One of the most common elements in the *Subcolumbites* fauna of Chios is this species. Renz and Renz (1948) had available for study several hundred specimens. Of this vast number of specimens 126 are sufficiently complete and well preserved to yield measurements of the basic conch dimensions. These data are tabulated on Table 31, and plotted on Figures 19 and 20. Renz and Renz (1948) recognized five species of this genus within the Chios fauna. These are: *originis*, *globulus*, *antiglobulus*, *globulus-originis*, and *globulus-antiglobulus*. The latter two species were named for intermediate forms between the first three species. These "Formenreihen" are distinguished basically on conch thickness and size of the umbilicus. *Isculitoides globulus*, considered by Renz and Renz as the point of origin of their "Formenreihen," is a globular form with a relatively small umbilicus. They recognized one series of transitional forms to *Isculitoides antiglobulus*, which has a more compressed conch and a more open umbilicus. Another series extended from *Isculitoides globulus* to *I. originis*, which is a compressed form with no appreciable difference in the diameter of the umbilicus. A plot of the whorl width (Fig. 19) and the umbilical diameter (Fig. 20) of these species recognized by Renz and Renz demonstrates the

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Figure 18. Diagrammatic representation of the sutures of various species of *Isculitoides*. A–I, *Isculitoides originis* (Arthaber), A–E from *Subcolumbites* fauna, Albania, F–I from *Subcolumbites* fauna, Chios. A, holotype (Arthaber, 1911: pl. 23(7), fig. 1c), no sutures are visible on the type specimen; B, paratype (Arthaber, 1911: pl. 23(7), fig. 9), redrawn from type specimen; C, paratype (Arthaber, 1911: pl. 23(7), fig. 6c), no sutures are visible on the type specimen; D, paratype (Arthaber, 1911: pl. 23(7), fig. 8), specimen apparently lost; E, paratype (Arthaber, 1911: pl. 23(7), fig. 9), specimen apparently lost; F, plesiotype (Renz and Renz, 1948: pl. 13, fig. 12b, NHMB J-13590), at a diameter of approximately 35 mm; G, plesiotype (Renz and Renz, 1948: pl. 13, fig. 11b, NHMB J-13591), at a diameter of approximately 35 mm; H, paratype *Isculites globulus* Renz and Renz (1948: pl. 14, fig. 8b, NHMB J-13602), at a diameter of approximately 25 mm; I, paratype *Isculites globulus* Renz and Renz (1948: pl. 14, fig. 11b, NHMB J-13600), at a diameter of approximately 25 mm; J–L, *I. ellipticus* Chao (1959) from *Subcolumbites* fauna, Kwangsi, China; J, holotype (Chao, 1959: fig. 38a), at a whorl height of 7 mm; K, paratype (Chao, 1959: fig. 38b), at a whorl height of 5 mm; L, paratype (Chao, 1959: pl. 30, fig. 3), at a diameter of approximately 25 mm; M, *I. suboviformis* (Kiparisova, 1961: fig. 97), from *Subcolumbites* fauna, Primorye Region, at a diameter of approximately 15 mm; N–P, *I. wasserbergi* n. sp. from *Subcolumbites* fauna, Tobin Formation, Nevada, N, paratype, at a diameter of 8.5 mm (MCZ 9626); O, paratype, at a diameter of 8 mm (MCZ 9450, Pl. 29, figs. 9, 10); P, paratype, at a diameter of 8 mm (MCZ 9657); Q, paratype *I. hammondi* n. sp., from Upper Thaynes Formation, Hammond Creek, southeast Idaho, at a diameter of 13 mm (MCZ 9480).

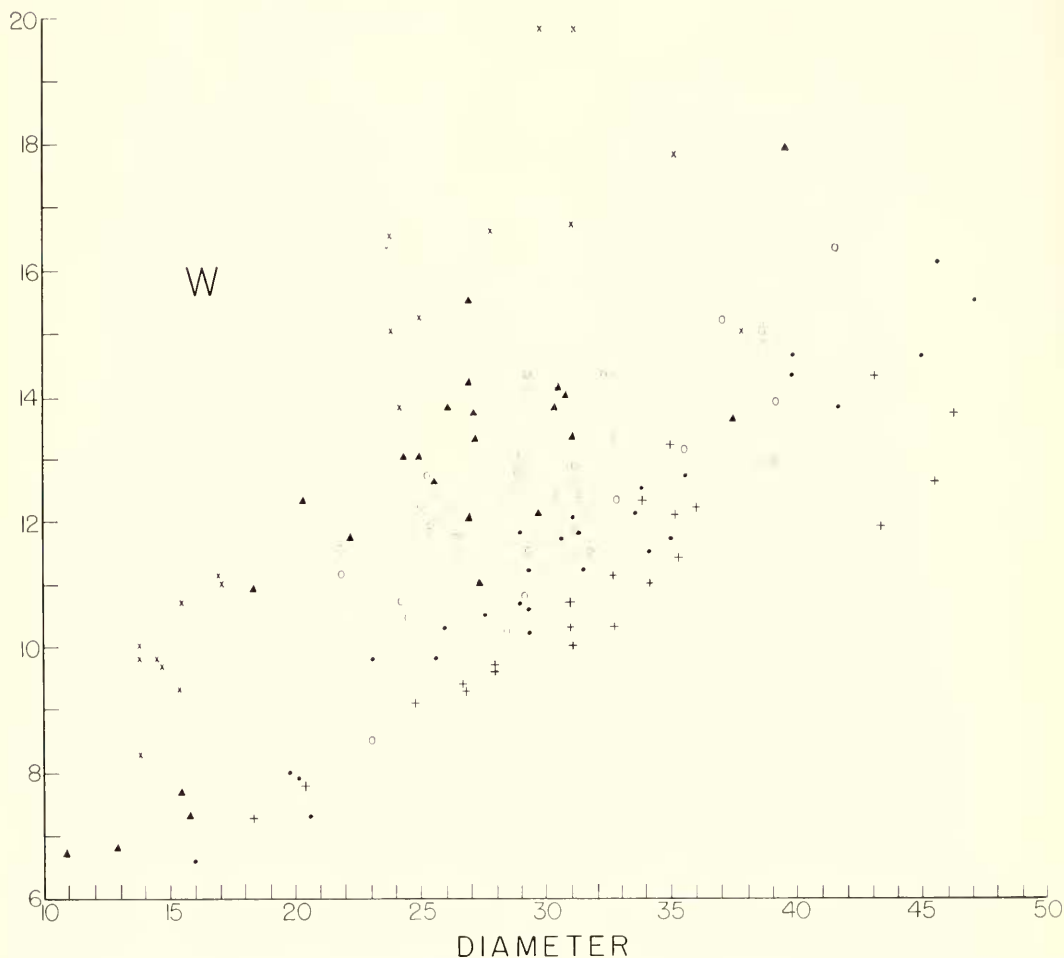


Figure 19. Variation in whorl width (W) of *Isculitoides originis* (Arthaber), from the *Subcolumbites* fauna of Chios. The data on this graph are from Table 31.

completely transitional nature of these two characters.

Renz and Renz (1948: 33) recognized that the basic plan of the suture was the same in the Chios and Albanian populations (Fig. 18 A-I). What variations do occur are minor changes in the shape of the elements and in the denticulation of the lobes.

Among late Scythian ammonite faunas, species of *Isculitoides* are recognized from Timor, Kwangsi, Primorye Region, British Columbia, Nevada, and southeastern Idaho. The Timor forms belong in *I.*

originis (Spath, 1934: 198). None of the remaining species are known by more than a few specimens, which makes comparison to *I. originis* difficult. *Isculitoides suboviformis* Kiparisova from the Primorye Region and *I. wasserbergi* n. sp. from Nevada are extremely depressed forms; *I. ellipticus* Chao from Kwangsi and *I. hammondi* n. sp. are similar in cone shape to *I. originis* but are much more involute, not showing as strong an excentrumbilication of the umbilicus.

Occurrence. *Subcolumbites* fauna of Albania and Chios, and from the man-

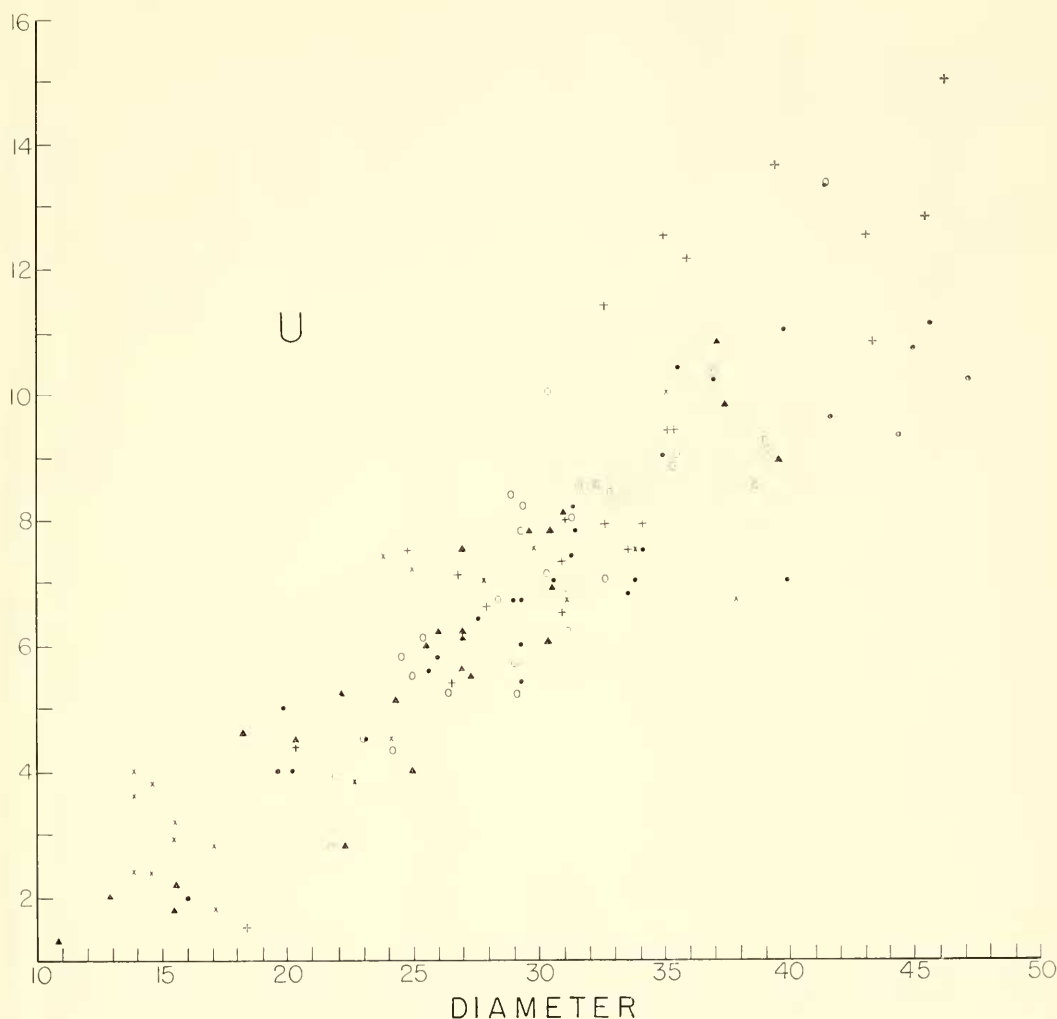


Figure 20. Variation in umbilical diameter (U) of *Isculitoides originis* (Arthaber), from *Subcolumbites* fauna of Chios. The data on this graph are from Table 31.

ganese coated fauna with *Prohungarites* of Nifoeckoko and Toeboelopo, Timor.

Repository. The genotype and 7 paratypes are preserved in the Paleontological Institute, University of Vienna. These are the specimens of Arthaber's plate 23(7), figs. 1–7, 10.

The specimens of this species from Chios described by Renz and Renz (1948) are in the Natural History Museum, Basel; these are as follows: plesiotypes, *I. orig-*

inis (pl. 13, fig. 7) NHMB J13584, (pl. 13, fig. 9) NHMB J13585, (pl. 13, fig. 11a) NHMB J13586, (pl. 13, fig. 11b) NHMB J13591, (pl. 13, fig. 12a) NHMB J13587, (pl. 13, fig. 12b) NHMB J13590, (pl. 14, fig. 6) NHMB J13588, (pl. 14, fig. 9) NHMB J13589; unfigured specimens of *I. originis* from Maradovuno NHMB J13592, J13593, J13594, from Kephlovuno NHMB J13595; holotype, *I. globulus* (pl. 14, fig. 10a, b) J13596, (pl. 14, fig. 10c) J13601; paratypes,

TABLE 31. MEASUREMENTS OF *ISCULITOIDES ORIGINIS* (ARTHABER) FROM THE SUBCOLUMBITES FAUNA OF CHIOS.

The species names on this list are those recognized by Renz and Renz (1948). The measurements are distinguished on Figure 19 and Figure 20.

	D	W	H	U	W/D	H/D	U/D		D	W	H	U	W/D	H/D	U/D
1.	47.2	15.5	20.0	10.2	32.8	42.4	21.6	33.	33.8	16.5±	14.8	7.5	48.8±	43.8	22.2
2.	45.7	16.1	17.8	11.1	35.2	38.9	24.3	34.	31.2	19.8	13.0	6.7	63.5	41.7	21.5
3.	45.0	14.6	19.2	10.7	32.4	42.7	23.8	35.	29.9	19.8	13.3	7.5	66.2	44.5	25.1
4.	44.4	?	19.6	9.3	?	44.1	20.9	36.	27.8	16.6	11.5	7.0	59.7	41.4	25.2
5.	41.7	13.8	16.3	9.6	33.1	39.1	23.0	37.	25.0	15.2	9.3	7.2	60.8	37.2	28.8
6.	39.8	14.6	18.1	7.0	36.7	45.5	17.6	38.	24.2	13.8 [?]	11.6	4.5	57.0 [?]	47.9	18.6
7.	39.8	14.3	15.2	11.0	35.9	38.2	27.6	39.	23.8	15.0	10.5	7.4	63.0	44.1	31.1
8.	37.0	?	14.0	10.2	?	37.8	27.6	40.	22.7	16.7	11.5	3.8	73.6	50.7	16.7
9.	35.6	12.7	13.9	10.4	35.7	39.0	29.2	41.	17.1	11.7	8.0	1.8	68.4	46.8	10.5
10.	35.0	11.7	13.5	9.0	33.4	38.6	25.7	42.	17.0	11.1	7.4	2.8	65.3	43.5	65.0
11.	34.2	11.5	14.8	7.5	33.6	43.3	21.9	43.	15.5	10.7	7.2	3.2	69.0	46.5	20.6
12.	33.8	12.5	14.2	7.0	37.0	42.0	20.7	44.	15.4	9.3	8.8	2.9	60.4	57.1	18.8
13.	33.6	12.1	14.2	6.8	36.0	42.3	20.2	45.	14.6	9.7	6.4	3.8	66.4	43.8	26.0
14.	31.5	11.2	12.8	7.8	35.6	40.6	24.8	46.	14.5	9.8	6.6	2.4 [?]	67.6	45.5	16.6 [?]
15.	31.4	12.1	13.2	8.2	38.5	42.0	26.1	47.	13.8	10.0	5.6	3.6	72.5	40.6	26.1
16.	31.3	11.8	12.3	7.4	37.7	39.3	23.6	48.	13.8	8.3	6.2	2.4	60.1	44.9	17.4
17.	30.7	11.7	12.1	7.0	38.1	39.4	22.8	49.	13.8	9.8	5.0	4.0	71.0	36.2	29.0
18.	29.3	11.2	12.0	6.7	38.2	41.0	22.9	<i>Isculitoides antiglobulus</i>							
19.	29.3	10.2	12.0	6.0	34.8	41.0	20.5	50.	46.3	13.7	16.4	15.0	29.6	35.4	32.4
20.	29.3	10.6	13.2	5.4	36.2	45.1	18.4	51.	45.5	12.6	16.8	12.8	27.7	36.9	28.1
21.	29.0	10.7	11.1	6.7	36.9	38.3	23.1	52.	43.3	11.9	16.6	10.8	27.5	38.3	24.9
22.	29.0	11.8	12.3	6.7	40.7	42.4	23.1	53.	43.2	14.3	16.1	12.5	33.1	37.3	28.9
23.	27.6	10.5	11.5	6.4	38.0	41.7	23.2	54.	39.5	?	14.0	13.6	?	35.4	34.4
24.	26.0	10.3	11.0	5.8	39.6	42.3	22.3	55.	36.0	12.2	11.9	12.1	33.9	33.1	33.6
25.	25.7	9.8	10.1	5.6	38.1	39.3	21.8	56.	35.3	11.4	13.7	9.4	32.3	38.8	26.6
26.	23.1	9.8	9.0	4.5	42.4	40.0	19.5	57.	35.2	12.1	14.7	9.4	34.4	41.8	26.7
27.	20.2	7.9	8.3	4.0	39.1	41.1	19.8	58.	35.0	13.2	12.5	12.5	37.7	35.7	35.7
28.	19.8	8.0	8.2	5.0	40.4	41.4	25.3	59.	34.1	11.0	13.4	7.9	32.3	39.3	23.2
29.	19.7	7.3	8.7	4.0	37.1	44.2	20.3	60.	33.6	12.3	13.8	7.4	36.6	41.1	22.0
30.	16.0	6.6	7.0	2.0	41.3	43.8	12.5	61.	32.7	10.3	13.3	7.9	31.5	40.7	24.2
<i>Isculitoides globulus</i>								62.	32.7	11.1 [?]	11.4	11.4	33.9 [?]	34.9	32.9
31.	37.8	15.0±	17.3	6.7	39.7±	45.8	17.7	63.	31.1	10.0	12.2	8.0	32.2	39.2	25.7
32.	35.2	17.8	12.6	10.0	50.6	35.8	28.4	64.	31.0	10.7	12.2	6.5	34.5	39.4	31.0

1. Plesiotype, Renz and Renz (1948: pl. 13, fig. 12), NHMB J13587.

2. Plesiotype, Renz and Renz (1948: pl. 13, fig. 11), NHMB J13586.

4. Plesiotype, Renz and Renz (1948: pl. 13, fig. 11b), NHMB J13591.

5. Plesiotype, Renz and Renz (1948: pl. 13, fig. 9), NHMB J13585.

6. Plesiotype, Renz and Renz (1948: pl. 13, fig. 12b), NHMB J13587.

11. Plesiotype, Renz and Renz (1948: pl. 13, fig. 7), NHMB J13584.

13. Plesiotype, Renz and Renz (1948: pl. 14, fig. 9), NHMB J13589.

26. Plesiotype, Renz and Renz (1948: pl. 14, fig. 6), NHMB J13588.

Remaining specimens from 3–30, unfigured paratypes from Maradovuno, Chios, NHMB J13592, 13593, 13594.

31. Paratype, Renz and Renz (1948: pl. 14, fig. 8b), NHMB J13602.

32. Paratype, Renz and Renz (1948: pl. 14, fig. 11), NHMB J13600.

33. Paratype, Renz and Renz (1948: pl. 14, fig. 8), NHMB J13599.

35. Holotype, Renz and Renz (1948: pl. 14, fig. 10), NHMB J13596.

37. Paratype, Renz and Renz (1948: pl. 14, fig. 4), NHMB J13597.

38. Paratype, Renz and Renz (1948: pl. 14, fig. 5), NHMB J13598.

40. Paratype, Renz and Renz (1948: pl. 14, fig. 10c), NHMB J13596.

Remaining specimens from 34–49, unfigured paratypes from Maradovuno, Chios, NHMB J13603.

50. Paratype, Renz and Renz (1948: pl. 13, fig. 1), NHMB J13606.

53. Paratype, Renz and Renz (1948: pl. 13, fig. 2), NHMB J13607.

54. Paratype, Renz and Renz (1948: pl. 13, fig. 3), NHMB J13608.

56. Paratype, Renz and Renz (1948: pl. 13, fig. 8), NHMB J13610.

58. Paratype, Renz and Renz (1948: pl. 13, fig. 5), NHMB J13609.

62. Holotype, Renz and Renz (1948: pl. 13, fig. 10), NHMB J13605.

Remaining specimens from 51–72, unfigured paratypes from Maradovuno, Chios, NHMB J13617.

TABLE 31. *Continued*

	D	W	H	U	W/D	H/D	U/D		D	W	H	U	W/D	H/D	U/D
65.	31.0	10.3	12.2	7.3	33.2	39.4	23.5	96.	12.9	6.8	6.8	2.0?	52.7	52.7	15.5?
66.	28.0	9.6	11.0	6.6	34.3	39.3	23.6	97.	10.8	6.7	5.5?	1.3?			
67.	28.0	9.7	11.2	6.6	34.6	40.0	23.6	<i>Isculitoides globulusantiglobulus</i>							
68.	26.8	9.3	11.0	7.1	34.7	41.0	26.5	98.	41.5	16.3	15.3	13.3	39.3	36.9	32.0
69.	26.6	9.4	12.2	5.4	35.3	45.9	20.3	99.	39.1	13.9	16.0	9.1	35.5	40.9	23.3
70.	24.8	9.1	9.1	7.5	36.7	36.7	30.2	100.	39.0	12.9	15.7	9.2	33.1	40.3	23.6
71.	20.4	7.8	8.3	4.4	38.2	40.7	21.6	101.	38.6	15.0	15.3	8.5	38.9	39.6	22.0
72.	18.4	7.3	9.3	1.5?	39.7	50.5	8.2?	102.	37.0	15.2	14.6	10.3	41.1	39.5	27.8
<i>Isculitoides globulusoriginis</i>								103.	35.5	13.1	14.5	9.0	36.9	40.8	25.4
73.	39.6	17.9	16.8	8.9	45.2	42.4	22.5	104.	35.3	12.7	13.5	8.8	36.0	38.2	24.9
74.	37.5	13.6	14.3	9.8	36.3	38.1	26.1	105.	32.8	12.3	13.3	8.4	37.5	40.5	25.3
75.	37.2	13.7	13.1	10.8	36.8	35.2	29.0	106.	32.7	13.2	14.0	7.0	40.4	42.8	21.4
76.	31.2	13.3?	13.2	8.1	42.6?	42.3	26.0	107.	31.7	11.5	12.6	8.5	36.3	39.7	26.8
77.	30.7	14.0	13.7	6.9	45.6	44.6	22.5	108.	31.3	12.3	12.7	8.0	39.3	40.6	25.6
78.	30.5	14.1	11.7	7.8	46.2	38.4	25.6	109.	31.2	11.8	13.7	6.2	37.8	43.9	19.9
79.	30.4	13.8	12.5	6.1	45.4	41.1	20.1	110.	31.1	12.8	12.3	6.9	41.2	39.5	22.2
80.	29.7	12.1	11.4	7.8	40.7	38.4	26.3	111.	30.3	12.3	12.3	7.1	40.6	40.6	23.4
81.	27.4	11.0?	12.4	5.5	40.1?	45.3	20.1	112.	30.3	14.2	11.7	10.0	46.9	38.6	33.0
82.	27.0	13.3	11.2	7.5	49.3	41.5	27.8	113.	29.3	14.3	11.5	7.8	48.8	39.2	26.6
83.	27.0	12.0	11.1	6.2	44.4	41.1	23.0	114.	29.3	11.5	11.1	8.2	39.2	37.9	28.0
84.	27.0	15.5	11.2	5.6	57.4	41.5	20.7	115.	29.2	10.8	13.0	5.2	37.0	44.5	17.8
85.	27.0	14.2	11.2	6.1	52.6	41.5	22.6	116.	29.0	13.0	12.4	5.7	44.8	42.8	19.7
86.	26.2	13.8	11.2	6.2	52.7	42.7	23.7	117.	28.8	12.7	9.8	8.4	44.1	34.0	29.2
87.	25.6	12.6	10.1	6.0	49.2	39.5	23.4	118.	28.4	10.2	10.9	6.7	35.9	38.4	23.6
88.	25.0	13.0?	11.6	4.0	52.0?	46.4	16.0	119.	26.4	11.7	11.6	5.2	44.3	43.9	19.7
89.	24.3	13.0	10.4	5.1	53.5	42.8	21.0	120.	25.4	11.9	11.0	6.1	46.9	43.3	24.0
90.	22.3	?	11.0	2.8	?	49.3	12.6	121.	25.0	12.2	11.4	5.5	48.8	45.6	22.0
91.	22.2	11.7	10.0	5.2	52.7	45.0	23.4	122.	24.5	10.4	10.3	5.8	42.4	42.0	23.7
92.	20.4	12.3	9.2	4.5	60.3	45.1	22.1	123.	24.2	10.7	10.2	4.3	44.2	42.1	17.8
93.	18.3	10.9	7.2	4.6	59.6	39.3	25.1	124.	23.0	8.5	10.3	4.5	36.9	44.8	19.6
94.	15.6	7.3	7.6	2.2	46.8	48.7	14.1	125.	21.8	11.1	9.3	3.9	50.9	42.7	17.9
95.	15.5	7.7	7.6	1.8	49.7	49.0	11.6	126.	21.7	11.5	11.1	2.8	52.9	51.2	12.9

74. Plesiotype, Renz and Renz (1948: pl. 14, fig. 2), NHMB J13615.

75. Plesiotype, Renz and Renz (1948: pl. 14, fig. 1), NHMB J13614.

76. Plesiotype, Renz and Renz (1948: pl. 14, fig. 3), NHMB J13616.

Remaining specimens from 73–97: unfigured paratypes from Maradovuno, Chios, NHMB J13617.

98. Plesiotype, Renz and Renz (1948: pl. 13, fig. 4), NHMB J13619.

112. Plesiotype, Renz and Renz (1948: pl. 14, fig. 7), NHMB J13620.

Remaining specimens from 99–126 unfigured paratypes from Maradovuno, Chios, NHMB J13621.

(pl. 14, fig. 4) J13597, (pl. 14, fig. 5) J13598, (pl. 14, fig. 8a) NHMB J13599, (pl. 14, fig. 8b) NHMB J13602, (pl. 14, fig. 11) NHMB J13600; unfigured paratypes from Maradovuno NHMB J13603, from Kephlovuno NHMB J13604; holotype, *I. antiglobulus* (pl. 13, fig. 10) NHMB J13605; paratypes (pl. 13, fig. 1) NHMB J13606, (pl. 13, fig. 2) NHMB J13607, (pl. 13, fig. 3) NHMB J13608, (pl. 13, fig. 5) NHMB J13609, (pl. 13, fig. 8) NHMB J13610; unfigured paratypes from Maradovuno NHMB J13612, from Kephlovuno

NHMB J13611; syntypes of *I. globulus-originis*, (pl. 13, fig. 6) NHMB J13613, (pl. 14, fig. 1) NHMB J13614, (pl. 14, fig. 2) NHMB J13615, (pl. 14, fig. 3) NHMB J13616; unfigured specimens from Maradovuno NHMB J13617, from Kephlovuno NHMB J13618; syntypes of *I. globulus-antiglobulus*, (pl. 13, fig. 4) NHMB J13619, (pl. 14, fig. 7) NHMB J13620; unfigured specimens from Maradovuno NHMB J13621, from Kephlovuno NHMB J13622; topotypes from Chios MCZ 10019, 10020. The specimens from

Timor are in the British Museum (Natural History).

Isculitoides ellipticus Chao
Text-figure 18

Isculitoides ellipticus Chao, 1959: 119, 293, pl. 26, figs. 24–28, pl. 30, figs. 1–5, text-fig. 38a, b.
Isculitoides aff. *originis* (Arthaber), Chao, 1959: 118, 292, pl. 26, figs. 22, 23.

Chao had one specimen of his *I.* aff. *originis* and four specimens assigned to *I. ellipticus*; for none of the specimens are any measurements given. All the specimens are compressed with rounded venters. The specimen assigned to *I.* aff. *originis* is slightly more evolute than *I. ellipticus*. We have already seen from the abundant material of *I. originis* from Chios that there can be a large amount of intraspecific variation. These Kwangsi specimens could well belong to *I. originis* or *I. hammondi* but the smallness of the sample does not allow a critical comparison. It seems best for the moment to recognize this species with the reservation that it is very close to *I. originis* and could well be conspecific. The sutures are illustrated on Figure 18 J–L.

Occurrence. The four specimens of *I. ellipticus* came from a loose block of limestone, stratigraphic position unknown, from near the Lolou village, Linglo district, Kwangsi, China (Chao collection 542b). Associated forms include species of *Procamites*, *Proptychitoides*, etc., which indicate a late Scythian *Subcolumbites* age. The single specimen of *I.* aff. *originis* came from the same place.

Isculitoides suboviformis (Kiparisova)
Text-figure 18

Paranannites suboviformis Kiparisova and Krish-tofovich, 1954: 21, pl. 11, figs. 4, 5; Kiparisova, 1961: 127, pl. 27, figs. 8, 9, text-figs. 94, 95.
Paranannites aff. *suboviformis* Kiparisova, 1961: 128, pl. 27, figs. 10, 11, text-figs. 96, 97.

This species has an extremely depressed whorl section as in *I. wasserbergi* and differs from that Nevada species mainly in lacking any radial ornamentation. Kipari-

TABLE 32. MEASUREMENTS OF *ISCULITOIDES WASSERBERGI* N. SP. FROM THE TOBIN FORMATION OF NEVADA.

	D	W	H	U	W/D	H/D	U/D
1.	14.7	13.8	6.1	3.0	93.9	40.5	20.45
2.	14.1	13.8	6.5	1.8	97.9	46.1	13.8
3.	13.0	11.0	6.1	2.0	84.7	46.9	15.4
4.	13.0	11.4	6.2	2.0	87.6	47.7	15.4?
5.	8.5	8.9	3.5	1.0?	105.2	41.1	11.8?
6.	7.3	8.1	3.7?	?	110.9	50.7?	?
7.	5.6	6.1	2.8	0.6?	108.3	50.0	10.7?

1. Holotype, MCZ 9447 (Pl. 29, figs. 1–3).
2. Paratype, MCZ 9448 (Pl. 29, figs. 4–6).
3. Paratype, MCZ 9449 (Pl. 29, figs. 7, 8).
- 4, 5, 7. Unfigured paratypes, MCZ 9485.
6. Paratype, MCZ 9450 (Pl. 29, figs. 9, 10).

sova (1961: 127) had only six specimens of this species; additional material may establish that the Nevada species is conspecific with this Siberian form. The suture is shown on Figure 18 M.

Occurrence. *Subcolumbites* fauna, Cape Zhitkov and Amur Bay, Primorye Region, Siberia.

Isculitoides minor Tozer

Isculitoides minor Tozer, 1965a: 20, pl. 2, figs. 1–3.

This is an involute *Isculitoides* on the pattern of *I. ellipticus* Chao, *I. suboviformis* Kiparisova, and *I. hammondi* n. sp. The species was based on only three specimens which makes comparisons difficult. It is highly possible that *I. ellipticus*, *I. minor*, and *I. hammondi* are conspecific, but for the moment at least it appears best to tentatively recognize all three species.

Occurrence. Toad Formation, Halfway River area, British Columbia.

Isculitoides wasserbergi n. sp.
Plate 29, figures 1–10; Text-figure 18

Small, tightly involute, globular conchs with highly depressed whorl sections, and excentric umbilici on the outer volutions. There are 13 specimens in the collection, of which 7 are sufficiently well preserved to yield the measurements shown in Table 32. The umbilical shoulder is well rounded, sloping gradually up to the very

broadly arched venter and flanks. The umbilical wall is steep. The conch of most specimens is smooth, except for faint growth lines. On some specimens, as that of Plate 29, figures 1, 2, there are a few narrow, low, rounded ridges extending straight across the venter from one umbilical shoulder to the other. The body chamber is at least one volution in length. The suture is simple, ceratitic with single pronged ventral lobes, a denticulated first lateral lobe lying midway between the ventral lobe and the umbilical shoulder, and a second lateral lobe on the umbilical wall (Fig. 18 N-P).

Isculitoides originis from the *Subcolumbites* faunas of Albania and Chios is extremely variable in conch dimensions, a variability typical of many excentrumbilicate ammonites. *Isculitoides wasserbergi* tends to resemble the more involute and globose variants, but still has a much more depressed whorl section and is more involute. Likewise, even though the Nevada sample is small, there is a suggestion at least that the amount of intraspecific variation is much less than that in *I. originis*.

This new species is most similar to *I. suboviformis* (Kiparisova) from the *Subcolumbites* fauna of the Primorye Region. In fact these two species have the most depressed whorls of any known *Isculitoides*.

Occurrence. Lower part of Tobin Formation, USGS Locality M2562, Pershing County, Nevada; south tip of Tobin Range, Cain Mountain 1:62,500 quad., center NW ¼ sec. 9, T. 26N, R. 39E, 5500 ft. S, 27.5 ft. W from elevation point 5088 on range crest.

Repository. Holotype, MCZ 9447 (Pl. 29, figs. 1-3); paratypes, MCZ 9448 (Pl. 29, figs. 4-6), MCZ 9449 (Pl. 29, figs. 7, 8), MCZ 9450 (Pl. 29, figs. 9, 10); suture specimens MCZ 9626, 9657; unfigured paratypes, MCZ 9485.

Isculitoides hammondi n. sp.

Plate 36, figures 8-13; Text-figure 18

This new species is represented by ap-

proximately 40 specimens, most of which are poorly preserved. The conch is subglobular to compressed and smooth. The venter is rounded, merging onto convex lateral areas. The umbilical shoulders are broadly rounded. The umbilicus is very small and markedly excentric on the outer volutions. Because of the weathered nature of most of the specimens, measurements are not possible. The conch, however, varies significantly from depressed forms (e.g. Pl. 36, figs. 11, 12) to compressed forms (e.g. Pl. 36, fig. 10). On the basis of the available specimens there appears to be a complete gradation between these extremes.

The suture is ceratitic with the first lateral lobe on the mid-part of the lateral areas, and a second lateral lobe on the umbilical shoulder (Fig. 18).

This species is quite distinct from *Isculitoides wasserbergi*, which is more depressed and constant in conch form, more evolute, and has at least some ornamentation. *Isculitoides originis* (Arthaber) from Albania and Chios displays a wide range in conch shape from depressed to compressed similar to that of *I. hammondi*. This Tethyan species tends to be more evolute and more markedly excentric than the Idaho species recorded here. The data on *Isculitoides ellipticus* Chao (1959) are limited, but there is a strong similarity to the Idaho species. It is not at all impossible that the Kwangsi and Idaho specimens are conspecific.

Occurrence. Uppermost member of Thaynes Formation, Hammond Creek, Bear River Range, southeast Idaho.

Repository. Holotype, MCZ 9477 (Pl. 36, fig. 8); paratypes MCZ 9478 (Pl. 36, figs. 9, 10), MCZ 9479 (Pl. 36, fig. 11), MCZ 9480 (Pl. 36, figs. 12, 13); unfigured paratypes MCZ 9486.

Genus *Chiotites* Renz and Renz, 1947

Type species, *Prosphingites* (*Chiotites*) *globularis* Renz and Renz, 1947

Small, very involute excentrumbilicate

forms, with contracting living chamber; a few prosiradiate constrictions near aperture; whorls depressed with broadly arched venter and rounded shoulders; living chamber bears prominent strigations. Suture with two denticulated lateral lobes, a denticulated auxiliary lobe above the umbilical shoulder and another one below the umbilical shoulder.

In its involute, excentrumbilicate conch this genus is quite similar to *Isculitoides* and *Protopites*, but the sutures of the latter two genera are very different. The suture of *Chiotites* is most similar to that of *Prosphingites* except for the additional auxiliary lobe.

The genus is known from a single species in the *Subcolumbites* fauna of Chios.

Chiotites globularis Renz and Renz

Text-figure 17

Prosphingites (*Chiotites*) *globularis* Renz and Renz, 1947: 60, 74; Renz and Renz, 1948: 40, pl. 15, figs. 9–9c.

Chiotites globularis,—Kummel, in Arkell et al., 1957: L139, fig. 172, 11.

Prosphingites (*Chiotites*) *superglobosus* Renz and Renz, 1947: 60, 75; Renz and Renz, 1948: 41, pl. 15, figs. 7–7b, 10.

The species *C. superglobosus* was introduced for the more inflated forms in the Chios fauna from Maradovumo. However, from the numerous paratypes in the Natural History Museum, Basel, it is quite clear that there is a complete gradational series from forms assigned to *globularis* to those placed in *superglobosus*. In their monograph the Renzes record only two specimens for each of their two species. There are in addition a number of specimens in Basel. These additional specimens are for the most part poorly preserved or unprepared. A suture is illustrated on Figure 17D. The measurements of the figured specimens are as follows:

	D	W	H	U	W/D	H/D	U/D
1.	22.2	13.3	8.5	8.7	59.9	38.3	39.2
2.	20.3	13.6	9.9	5.1	67.0	48.8	25.1
3.	21.8	16.8	7.3	5.7	77.1	33.5	26.1
4.	22.6	?	7.8	7.0	?	34.5	31.0

1. Holotype, Renz and Renz (1948: pl. 15, fig. 9), NHMB J13642.
2. Paratype, Renz and Renz (1948: pl. 15, fig. 9c), NHMB J13643.
3. Holotype, *C. superglobosus* Renz and Renz (1948: pl. 15, fig. 7), NHMB J13645.
4. Paratype, *C. superglobosus* Renz and Renz (1948: pl. 15, fig. 10), NHMB J13646.

Occurrence. *Subcolumbites* fauna, Maradovumo, Chios.

Repository. Holotype, NHMB J13642; paratypes NHMB J13643 (Renz and Renz, 1948: pl. 15, fig. 9c); unfigured paratypes from Maradovumo NHMB J13644; holotype *superglobosus* Renz and Renz (1948: pl. 15, fig. 7) NHMB J13645; paratype (Renz and Renz, 1948: pl. 15, fig. 10) NHMB J13646; unfigured paratypes from Maradovumo NHMB J13647.

Genus *Czekanowskites* Diener, 1915

Type species, *Ceratites decipiens* Mojsisovics, 1886

Czekanowskites decipiens (Mojsisovics)

Ceratites decipiens Mojsisovics, 1886: 27, pl. 6, fig. 9.

Czekanowskites decipiens,—Diener, 1915: 115; Spath, 1934: 264; Kummel in Arkell et al., 1957: L143, fig. 175, 2; Kummel, 1961: 521.

Ceratites inostranzeffi Mojsisovics, 1886: 28, pl. 6, fig. 10.

Czekanowskites inostranzeffi,—Diener, 1915: 115; Kummel, 1961: 521.

It is unfortunate that in the extensive revision of the Siberian Olenek fauna Popov (1961, 1962a) apparently had no additional specimens of this interesting genus and species. There have been few other records of the species since its introduction by Mojsisovics. The specimen from the *Arctoceras* horizon on Spitsbergen that Frebold (1930) described as *Czekanowskites* (?) sp. nov. does not belong in this genus. Kummel (1954) recorded a fragmentary specimen that probably belongs to this genus and is described below.

Occurrence. *Olenekites* Zone, Olenek River region, Siberia.

Czekanowskites cf. *decipiens* (Mojsisovics)

Czekanowskites? sp. Kummel, 1954: 187.

A fragment consisting of a quarter volu-

tion of living chamber is believed to belong to this genus, which is known from only one species in the upper Scythian strata at the mouth of the Olenek River, Siberia. The adoral part of the fragment measures 19 mm high and 17.5 mm in width. The whorl section is subquadrate in outline with a broad, low arched venter, rounded ventral shoulders, lateral areas that are only slightly convex and convergent, rounded umbilical shoulders, and a steep umbilical wall. The lateral areas bear radial ribs that enlarge slightly towards the ventral shoulders. There is a faint trace of the ribs across the venter, which gives the venter an undulating appearance. The posterior end of this fragment has some traces of the last septum, enough to indicate that there is a large first lateral lobe, adjacent to large rounded saddles. The second lateral lobe is high on the lateral areas and is much smaller, and there is probably a very small auxiliary lobe on the umbilical wall.

This fragment is assigned to *Czekanowskites* on the basis of the great similarity of the whorl outline and pattern of ribs to the Siberian species of this genus. The suture, insofar as it can be observed, is also similar in basic pattern to that of the Siberian species. The major difference appears to be in the nature of the venter. The Siberian species appears to have a smooth venter, whereas the form recorded here has traces of the ribs across the venter.

Occurrence. Upper member of the Thaynes Formation, Hammond Creek, Bear River Range, southeast Idaho.

Repository. MCZ 9649.

Genus *Popovites* Tozer, 1965

Type species, *Popovites occidentalis* Tozer, 1965

"Inner whorls globose, outer whorl of approximately equal height and width, with a perpendicular umbilical wall, prominent, rounded umbilical shoulder, flat sides, and a broadly arched or slightly

flattened venter. Sculpture consists of regular growth lines; radial wrinkles or faint ribs may also occur on the venter. Constrictions are absent. Body chamber about one whorl in length. The suture line comprises: a deep external lobe, with incised branches; two ceratitic lateral lobes; a suspensive lobe with one or more auxiliary incisions; and one internal lateral lobe" (Tozer, 1965a: 21).

This new genus shows marked affinities to *Prosphingites*, on the one hand, and to *Czekanowskites*, on the other. The suture of *Popovites* is quite similar to that of *Prosphingites* and at the same time not as elaborate as the suture of *Czekanowskites*. There is, however, in the fairly large size of the first lateral lobe a similarity in the suture of *Popovites* and *Czekanowskites* (Fig. 17E). The general conch form of this new group of ammonites is like that in various species of *Prosphingites* and *Czekanowskites*.

The genus is known by two species from an upper Scythian horizon in British Columbia and Ellesmere Island.

Popovites occidentalis Tozer

Text-figure 17

Popovites occidentalis Tozer, 1965a: 22, pl. 3, figs. 2-12, text-figure 5.

The type species is well illustrated and described by Tozer (1965a, Fig. 17E of this report). It differs from *P. borealis* only in being slightly more involute; however, since that species is based on a single specimen, there is no way of evaluating the significance of this difference. Among the measured specimens of *P. occidentalis* there is only a variation of 5 percent in the diameter of the umbilicus (Tozer, 1965a: p. 23). The umbilical diameter of the holotype of *P. borealis* is 31 percent at a diameter of 31 mm and 35 percent at a diameter of 43 mm. This is 5 and 10 percent, respectively, greater than the maximum diameter of the umbilicus for *P. occidentalis*.

Occurrence. Toad Formation, Halfway River area, British Columbia, associated

with *Preflorianites intermedius* Tozer and *Monacanthites monoceros* Tozer.

***Popovites borealis* Tozer**

Popovites borealis Tozer, 1965a: 24, pl. 3, figs. 1a, b, text-figure 6.

See above for discussion of this species.

Occurrence. Blaa Mountain Formation, lower shale member, Ellesmere Island.

Genus *Monacanthites* Tozer, 1965

Type species, *Monacanthites monoceros* Tozer, 1965

"Globose ammonoids with sculpture of widely spaced, unbranched ribs that are curved to form a sharp ventral sinus. On the outer whorl each rib, at the ventral mid-line, carries a single, solid spine. Body chamber one whorl in length. Suture ceratitic, with two lateral lobes, both internally and externally" (Tozer, 1965a: 27).

***Monacanthites monoceros* Tozer**

Text-figure 17

Monacanthites monoceros Tozer, 1965a: 27, pl. 1, figs. 8-10, pl. 2, fig. 4, text-fig. 8.

A unique species, quite unlike any other ammonite of comparable age (Fig. 17F).

Occurrence. Toad Formation, Halfway River area, British Columbia, associated with *Preflorianites intermedius* Tozer and *Popovites occidentalis* Tozer.

Genus *Tunglanites* Chao, 1959

Type species, *Tunglanites lenticularis* Chao, 1959

Involute, compressed conch with narrowly rounded to acute venter; inner volutions more inflated, bearing oblique constrictions. Body chamber of one volution. Suture with single ceratitic lateral lobe, two rounded lateral saddles.

The combination of conch shape and suture of this genus is unique among late Scythian ammonoids. The group was first recognized from the *Subcolumbites* fauna of Albania by Arthaber (1911) who placed it in the genus *Styrites* of much younger

age. This generic assignment for this late Scythian form has never been accepted. Diener (1915: 271) listed it with question in the genus *Styrites*, and Spath (1934: 197) clearly recognized the independent status of this form but refrained from proposing a new generic name, most likely because data on the Albanian forms were very incomplete. Renz and Renz (1948) gave no indication that they were familiar with any literature on this form after the publication of Arthaber's paper in 1911.

The discovery of eight specimens in the *Subcolumbites* fauna of Kwangsi, China, has enabled a much clearer understanding of the group, and a new generic name is well justified.

There are at present two species of the genus *Tunglanites*, *T. lenticularis* Chao, the type species, and *T. alexi* n. sp. for the Albanian and Chios forms assigned to *Styrites lilangensis* Diener by Arthaber and Renz and Renz, respectively. Direct comparison of these two species is handicapped by the incompleteness in our knowledge of the Albanian and Chios specimens. Unfortunately, one of the specimens studied by Arthaber is lost and the Chios fauna has yielded only two specimens. These western Tethyan specimens were thought by both Arthaber and the Renzes to have a goniatitic lateral lobe. However, the preservation, in hard red limestone, makes development of the suture extremely difficult, and the smooth character of the lobe may be due to over grinding or etching. Regardless of this there can be no doubt of the close relationship, and perhaps even identity, of these two species.

In regard to the genetic relations of the group, Spath (1934: 197) suggested they represent a specialized offshoot of *Isculitoides*. The recognition of faint constrictions on the early volutions of the Kwangsi specimens, the compression of the conch, and nature of the suture make this suggestion perfectly reasonable.

In the three localities where *Tunglanites* has been recorded, Albania, Chios, and

Kwangsi, China, the associated fauna includes such typical upper Scythian genera as *Subcolumbites*, *Proptychitoides*, and *Hemilecanites*.

Tunglanites lenticularis Chao

Text-figure 21

Tunglanites lenticularis Chao, 1959: 120, 294, pl. 27, figs. 25–32, pl. 28, figs. 23–25.

Involute, compressed, small conch with rounded venter on early volutions becoming acute on last volution. Living chamber one volution or more in length. Surface may bear fine striae of growth which curve backward along flanks; constrictions may be present on early volutions. Suture with broad ventral lobe, two rounded lateral saddles and single lateral lobe; occasionally a second lateral lobe is present on the umbilical shoulder and wall.

Chao established his new genus and species on the basis of eight specimens of which three were illustrated. It appears that the umbilicus is completely closed on the earlier volution and gradually opens slightly on the more adoral volutions. The only other recorded occurrence of this genus is that of specimens from Albania and Chios which are very similar in over-all appearance to this Kwangsi species. The western Tethyan specimens have a more open umbilicus at a smaller diameter; however, the significance of this difference is questionable. More material is needed to evaluate the ontogenetic changes in growth. Another distinctive feature is the suture (Fig. 21A). The Chios and Albanian specimens are reported to have smooth lobes. However, the preservation of these specimens in hard red limestone requires grinding and acid to observe the suture in most cases. It is not at all certain that the lobes are really goniatitic. The Albanian specimen described by Arthaber (1911: 260, pl. 23(7), fig. 12) as *Styrites lilangensis* Diener does not show a suture; just where Arthaber obtained the suture of his figure 12c is a puzzle (Fig. 21B). The specimen from Chios described by Renz and

Renz (1948: 31, pl. 12, fig. 4) does not show the suture clearly enough to establish whether it is really goniatitic. I strongly suspect that the lateral lobe is indeed denticulated.

Occurrence. From a black, thin bedded limestone 0.6 meters thick and 14 meters above the lower Permian Maokou Limestone (Chao collection 542b); the Chashanao section of Chao (1959: 162) at the border of Hochich and Tunglan districts (Chao collection 610), western Kwangsi, China. The Scythian strata at this locality comprise only about 16 meters of shale and limestone. The only fossils present are from this 0.6 meter bed, which in addition to *Tunglanites* contains *Subcolumbites*, *Proptychitoides* and *Hemilecanites*.

Tunglanites alexi n. sp.

Plate 20, figures 1, 2; Text-figure 21

Styrites lilangensis,—Arthaber (non Diener), 1911: 260, pl. 23(7), figs. 11a, b, 12a, b, c; Renz and Renz, 1947: 60; Renz and Renz, 1948: 31, pl. 12, figs. 4–4a.

Styrites (?) cf. *lilangensis* Diener, 1915: 271. Gen. nov. "*Styrites*" *lilangensis*,—Spath, 1934: 189, 197.

This species is established for the specimens Arthaber (1911) and Renz and Renz (1948) described as *Styrites lilangensis* Diener from the *Subcolumbites* faunas of Albania and Chios. Arthaber had two specimens from Albania both of which he illustrated; the smaller of his two specimens (Arthaber, 1911: pl. 23(7), fig. 11) is lost, but the larger specimen (Arthaber, 1911: pl. 23(7), fig. 12) is available and is selected as the type specimen. The diameter of this specimen is approximately 30 mm, the width of the adoral whorl 8.5 mm, the height 12.5 and the diameter of the umbilicus 6.7 mm. A portion of the phragmocone is broken off and missing. The whorls are compressed and convergent, forming an acute venter. The umbilical shoulders are very low but rounded; the umbilicus is excentrumbilicate. Arthaber (1911: pl. 23(7), fig. 12c) shows a suture (Fig. 21B of this report) which presum-

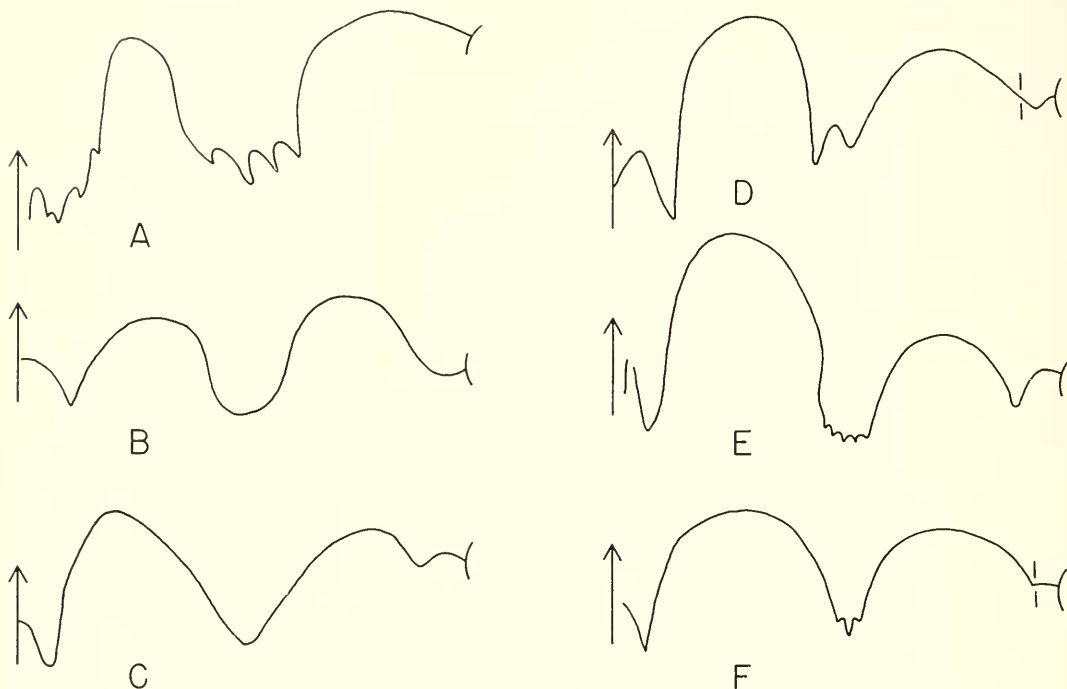


Figure 21. Diagrammatic representation of the suture of: A, *Tungranites lenticularis* Chao from an upper Scythian horizon in Kwangsi, China (1959: pl. 27, fig. 32), at a diameter of approximately 15 mm; B, *Tungranites alexi* n. sp. (= *Styrites lilangensis*,—Arthaber, 1911: pl. 23(7), fig. 12c) from *Subcolumbites* fauna of Albania, suture presumably from paratype of Arthaber (1911: pl. 23(7), fig. 11) which is apparently lost; C, *Paradinarites suni* Chao (1950: fig. 4), holotype, at a diameter of approximately 30 mm; D, *Pseudocelites constrictilis* (Astakhova, 1960: fig. 8) from *Columbites* Zone of Astakhova (1960) on the Mangyshlok Peninsula, at a diameter of approximately 15 mm; E, *Pseudocelites nevadi* n. sp., from Upper Thaynes Formation, Confusion Range, Utah, un-numbered paratype at whorl height of approximately 10 mm; F, *Pseudocelites nevadi* n. sp., from Upper Thaynes Formation, Confusion Range, Utah, un-numbered paratype at whorl height of approximately 10 mm.

ably was taken off the other type specimen. Careful examination of this specimen has failed to show any trace of a suture.

The specimen from the *Subcolumbites* fauna of Chios illustrated by Renz and Renz (1948: pl. 12, fig. 4) measures 17.1 mm in diameter, 5.2⁹ mm for the width of the adoral whorl, 7.0 mm for the height of the adoral whorl and 3.5 mm for the diameter of the umbilicus. Renz and Renz state that their Chios specimen had a goniatitic suture; however, my examination of the specimen reveals that the suture is not well preserved and it cannot be established whether it is goniatitic or not. I strongly suspect that the lateral lobe is indeed denticulated.

The general shape of the conch is very much like that of *T. lenticularis* except for an apparently slightly larger umbilicus.

Occurrence. *Subcolumbites* fauna of Albania and Chios.

Repository. Holotype (Pl. 20, figs. 1, 2), Paleontological Institute, University of Vienna; specimens from Chios NHMB J13582 (Renz and Renz, 1948: pl. 12, fig. 4), unfigured specimen NHMB J13583.

Genus *Columbites* Hyatt and Smith, 1905
Type species, *Columbites parisianus* Hyatt and Smith, 1905

Columbites parisianus Hyatt and Smith

Plate 39, figures 1–10; Plate 40, figures 1–11; Plate 41, figures 1–7;

Plate 42, figures 1–9; Plate 43, figures 4, 5; Text-figures 22, 23.

Columbites parisianus Hyatt and Smith, 1905: 51, pl. 1, figs. 9–14, pl. 61, figs. 1–21, pl. 72, figs. 1–24; Frech, 1908: pl. 42, fig. 2; Diener, 1915: 112; Diener, 1925: 69, pl. 24, fig. 2; Smith, 1932: 107, pl. 1, figs. 9–14, pl. 61, figs. 1–21, pl. 72, figs. 1–24; Spath, 1934: 201, pl. 13, fig. 3, text-fig. 61; Kummel, in Arkell, et al., 1957: L140, fig. 172, 2.

Columbites spencei Smith, 1914: 36, pl. 70, figs. 1–16, pl. 71, figs. 1–16; Smith, 1932: 108, pl. 77, figs. 1–21, pl. 78, figs. 1–16; Kutassy, 1933: 490.

Columbites consanguineus Smith, 1932: 106, pl. 46, figs. 1–13.

Columbites minimus Smith, 1932: 106, pl. 47, figs. 9, 10.

Columbites ligatus Smith, 1932: 106, pl. 47, figs. 1–8.

Columbites ornatus Smith, 1932: 107, pl. 46, figs. 14–21.

All the specimens assigned to the six species of *Columbites* by J. P. Smith came from outcrops of the middle shale member of the Thaynes Formation (*Columbites* fauna) in Paris Canyon, southeast Idaho. The original description of the type species by Hyatt and Smith (1905), later slightly enlarged by Smith (1932), is quite adequate. The five additional "species" introduced by Smith in 1932 were distinguished on differences in whorl dimensions and on ornamentation. On Table 33 are given the measurements of 107 specimens of *Columbites* from the same horizon, at three localities around the north end of Bear Lake (including Paris Canyon), southeast Idaho. These data are plotted on Figure 23. It can readily be seen from this large sample that slight differences in conch dimensions are meaningless. The differences in ornamentation are more difficult to quantify. But here again, as with most ornamented ammonites, there is complete gradation from very weak ribs to strong ribs; within this species there is also an ontogenetic variable, that is, successive patterns of ribs appear in differing orders. All of these features, however, are completely gradational. Close study of the

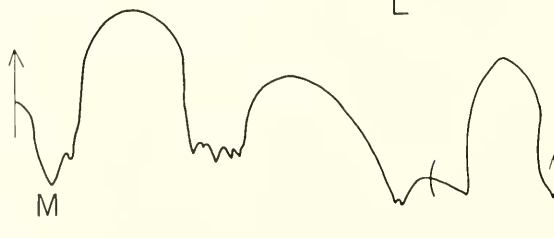
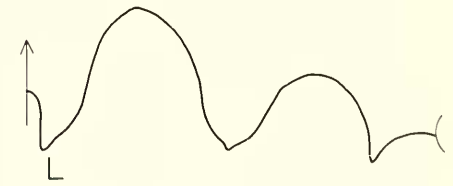
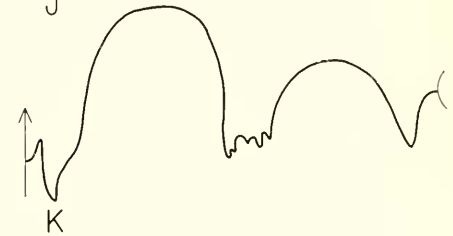
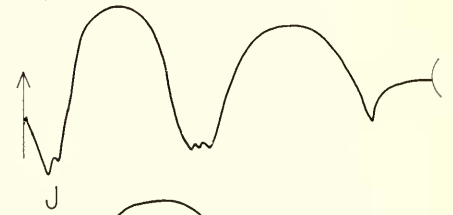
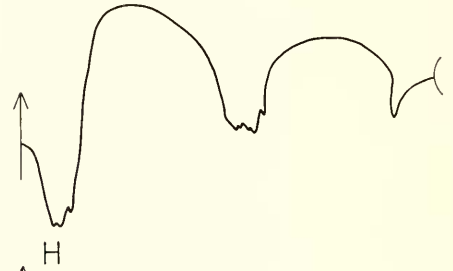
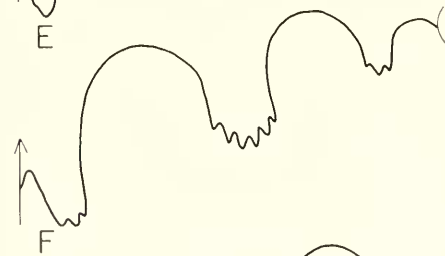
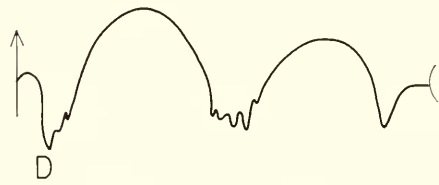
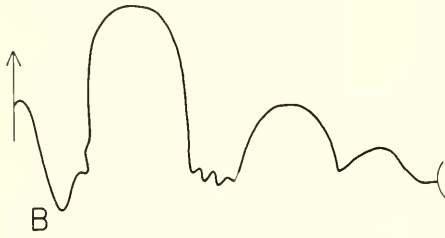
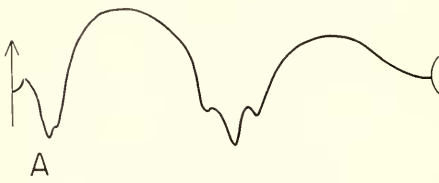
specimens figured here will bring this fact out.

Smith (1932) did not make particular note of the suture of his six species but this feature is also quite variable. On Figure 22 are 13 sutures of *Columbites*. As can be seen, the variation is expressed in the shape and size of the first and second lateral lobe and thus also in the saddles.

There are no other well authenticated species of *Columbites* recorded to date. *Columbites* sp. described by Kiparisova (1961:119) from an uncertain horizon (*Columbites* Zone?) in the Scythian of the Primorye Region is based on a single poorly preserved specimen. It is possible this is a species of *Columbites*, but it is much more involute than *C. parisianus*. At the same time it could well be a species of *Pseudoceltites*. From northern Siberia, Popov (1961) has described two species of *Columbites*, *Columbites* (?) aff. *ornatus* Smith and *Columbites morpheos* Popov. The first of these records is based on two poorly preserved casts showing no suture; I believe these to be unidentifiable. The second, *C. morpheos*, is a species of *Tirolites* and is discussed under that genus in this paper. Finally, there are *Columbites dolnopaensis* Kiparisova (1947: 143) and *Columbites constrictilis* Astakhova (1960: pl. 140) from the Mangyshlak Peninsula of southern Russia. These two species belong in *Pseudoceltites* and are discussed under that genus. *Columbites parisianus* is thus far only known from southeast Idaho.

Occurrence. Middle shale member, Thaynes Formation, *Columbites* fauna at Paris Canyon, Montpelier Canyon, and Hot Springs, all around north end of Bear Lake, southeast Idaho, and same horizon along Draney Creek, Stewart Flat Quadrangle, southeast Idaho (USGS locality M98).

Repository. Holotype (Pl. 39, figs. 3, 4) USNM 75246a; paratypes (Pl. 39, figs. 8, 9) USNM 75246b, (Pl. 41, fig. 7) USNM 75286a, (Pl. 39, figs. 1, 2) USNM 75286b, (Pl. 39, figs. 5–7) USNM 75286c, (Smith,



1932, pl. 61, figs. 8, 9) USNM 75286d, (Pl. 39, fig. 10) USNM 75286e; all the remaining small juvenile specimens of this species studied by Hyatt and Smith (1905) and Smith (1932) are in the U.S. National Museum but are not formally numbered; suture specimens of Figure 22, MCZ 9532–9538; specimens from Montpelier Canyon MCZ 9633, from Hot Springs 9634; from Draney Creek, Stewart Flat Quadrangle, southeast Idaho, USGS; holotype *C. consanguineus* Smith, (Pl. 41, figs. 1, 2) USNM 74983a; paratypes (Pl. 41, figs. 3, 4) USNM 74983b, (Pl. 41, figs. 5, 6) USNM 74983c, (Smith, 1932: pl. 46, figs. 7–9) USNM 74983d, (Smith, 1932: pl. 46, figs. 10–13) USNM 74983e; holotype *C. ligatus* Smith, (Pl. 43, figs. 4, 5) USNM 74985a; paratypes (Pl. 42, fig. 7) USNM 74985b, (Pl. 40, figs. 7–9) USNM 74985c; holotype *C. minimus* (Smith, 1932: pl. 47, figs. 9, 10) USNM 74986; holotype *C. ornatus* Smith, (Pl. 40, figs. 1, 2) USNM 74984a; paratypes (Pl. 40, figs. 10, 11) USNM 74984b, (Smith, 1932: pl. 46, figs. 19–21) USNM 74984c; holotype *C. spencei* Smith (Pl. 42, figs. 1, 2) USNM 75309; paratypes (Smith, 1932: pl. 78, fig. 3) USNM 75309b, (Pl. 42, figs. 3, 4) USNM 75309c, (Pl. 42, figs. 8, 9) USNM 75309d, (Pl. 42, figs. 5, 6) USNM 75309e, (Pl. 40, figs. 5, 6) USNM 75309f, (Pl. 40, figs. 3, 4) USNM 75309g, specimens of Smith (1932: pl. 77, figs. 1–21) USNM 75309h–i.

Genus *Subcolumbites* Spath, 1930

Type species, *Columbites perrinismithi* Arthaber, 1908

The most common elements in many late Scythian faunas are species of *Subcolumbites*. The five species of this genus recognized to date can be separated into three distinct groups. The first group contains only the type species, which is known from Albania, Chios, China, and Japan, and is characterized by carination of the venter. The second group contains only *S. dusmani*, and is characterized by a more marked development of reticulate ornamentation. The third group contains *S. robustus* from China, *S. multiformis* from the Primorye Region, and *S. americanus* from Nevada. This third group is characterized by a more depressed whorl section.

Subcolumbites perrinismithi (Arthaber)

Plate 1, figures 1–9; Plate 2, figures 5–8; Plate 3, figures 1–9; Plate 4, figures 1–4; Text-figure 24

Columbites perrini-smithi Arthaber, 1908: 277, pl. 12, fig. 1; Arthaber, 1911: 262, pl. 23(7), figs. 19, 20; Diener, 1915: 112; C. Renz, 1928: 155; Renz and Renz, 1947: 59; Renz and Renz, 1948: 20, pl. 11, figs. 7–7a.

Subcolumbites perrini-smithi,—Spath, 1930: 77; Spath, 1934: 203, pl. 12, figs. 5a, b; Kummel, in Arkell et al., 1957: L140, figs. 172, 15a, b; Kummel, 1968b: 495, pl. 1, figs. 1–3.

Columbites europaeus Arthaber, 1908: 278, pl. 12, fig. 2; Arthaber, 1911: 261, pl. 23(7),

Figure 22. Diagrammatic representation of the sutures of *Columbites parisianus* Hyatt and Smith. A, suture of holotype at a diameter of 35 mm (USNM 75246a), from Smith (1932: pl. 1, fig. 11); B, at a diameter of 35 mm (USNM 75286b), from Smith (1932: pl. 61, fig. 4); C, suture of holotype of *C. ligatus* Smith (1932: pl. 47, fig. 3), at a diameter of 40 mm (USNM 74985a); D, at a diameter of 46.7 mm (MCZ 9532); E, at a diameter of 22.3 mm (MCZ 9533); F, paratype of *C. spencei* Smith (1932: pl. 78, fig. 4), at an approximate diameter of 35 mm (USNM 75309b); G, paratype of *C. consanguineus* Smith (1932: pl. 46, fig. 4), at a diameter of approximately 40 mm (USNM 74983b); H, at a diameter of 42.0 mm (MCZ 9534); I, paratype of *C. ornatus* Smith (1937: pl. 46, fig. 18), at a diameter of 25 mm (USNM 74984b); J, at a diameter of 28.6 mm (MCZ 9535); K, at a diameter of 33.7 mm (MCZ 9536); L, at a diameter of 23.0 mm (MCZ 9537); M, at a whorl height of 10 mm (MCZ 9538). All specimens from *Columbites* fauna, Thaynes Formation, southeast Idaho; A, B, C, F, G, I, are from Paris Canyon, the remaining specimens from Hot Springs.

TABLE 33. MEASUREMENTS OF *COLUMBITES PARISIANUS* HYATT AND SMITH FROM *COLUMBITES* FAUNA FROM THREE LOCALITIES AROUND NORTH END OF BEAR LAKE, SOUTHEAST IDAHO.

	D	W	H	U	W/D	H/D	U/D		D	W	H	U	W/D	H/D	U/D
1.	67.9	17.3	18.4	34.8	25.5	27.1	51.4	41.	40.3	?	10.8	20.4	?	27.0	50.5
2.	66.2	16.0	19.5	32.2	24.2	29.4	49.4	42.	39.4	12.0	10.5	20.8	30.5	26.7	52.8
3.	65.0	16.5	18.8	31.8	24.4	39.0	49.0	43.	39.0	11.4	11.9	17.7	29.2	30.5	45.5
4.	63.0	16.0	19.4	27.4	25.4	30.8	43.5	44.	38.7	11.0	12.5	16.5	28.4	32.3	42.7
5.	62.5	16.9	16.7	30.4?	27.1	26.7	54.4?	45.	38.3	11.0	11.7	18.6	28.7	30.6	48.6
6.	61.7	15.3	20.6	25.9	24.8	33.4	42.0	46.	37.8	11.9	12.0	17.8	31.5	31.7	47.1
7.	59.7	15.0	19.1	25.0	25.1	32.0	41.9	47.	37.6	11.9	11.3	17.8	31.6	30.1	47.4
8.	59.0	15.4	16.1	29.5	25.8	26.9	49.3	48.	37.3	11.9	10.0	18.5	31.9	26.8	49.6
9.	58.7	15.8	15.0	32.7	27.1	25.5	55.6	49.	36.7	11.8	9.4	18.7	32.2	25.1	51.0
10.	58.5	16.6	16.4	30.2	28.4	28.1	51.6	50.	36.4	12.0	10.3	17.8	33.0	27.5	48.9
11.	58.3	16.7	18.4	28.3	28.6	31.6	48.6	51.	35.8	10.6	10.1	17.5	30.5	28.2	48.9
12.	56.5	17.3?	15.6	29.0	30.6?	27.6	51.3	52.	35.7	11.4	10.1	18.0	31.9	28.3	50.5
13.	54.5	14.2	17.1	24.2	26.1	31.4	44.4	53.	35.6	11.2	10.3	18.4	31.3	28.9	50.6
14.	54.0	15.5?	17.2	23.7	28.7?	31.9	43.9	54.	35.3	13.3	9.3	18.5	37.7	26.3	52.4
15.	54.0	14.4	17.4	25.3	26.7	32.3	46.9	55.	35.0	10.5	9.8	16.4	30.0	28.0	46.9
16.	53.5	15.4	15.0	27.8	28.8	28.0	52.0	56.	33.8	12.7	8.8	17.8	37.6	26.0	52.7
17.	52.4	15.7	14.3	26.1	30.0	27.3	49.8	57.	33.4	10.5	9.2	17.3	31.5	27.5	51.8
18.	50.7	14.4	14.0	25.8	28.4	27.8	50.8	58.	33.2	9.7	11.1	14.5	29.2	33.4	43.7
19.	50.5	14.0	15.0	24.3	27.7	29.7	48.1	59.	32.1	10.5	10.0	15.0	32.7	31.2	46.7
20.	50.5	14.7	13.5	27.3	29.2	26.7	54.1	60.	31.4	11.7	8.9	16.1	37.3	28.3	51.3
21.	49.8	12.8	15.5	23.4	25.7	31.2	47.0	61.	31.4	11.0	11.2	12.5	35.0	35.7	39.9
22.	49.7	?	14.8	24.7	?	29.7	49.5	62.	30.9	13.9	8.4	16.2	45.0	27.2	52.5
23.	49.4	15.8	13.8	25.2	32.0	28.0	50.6	63.	30.8	11.3	10.5	13.0	36.9	34.1	42.3
24.	49.0	13.7	15.0	20.8	27.9	30.6	42.4	64.	30.5	10.8	7.5	16.2	34.8	24.6	53.2
25.	48.7	15.0	12.5	27.8	30.7	25.6	56.9	65.	30.3	11.5	10.2	13.2	38.0	33.6	43.6
26.	48.4	13.4	16.3	21.1	27.7	33.7	43.6	66.	29.0	10.0	8.7	13.7	34.5	30.0	47.3
27.	48.2	9.4	12.9	24.4	19.5	26.7	50.6	67.	29.0	10.0	7.7	15.0	34.5	26.5	51.7
28.	48.2	13.7	13.7	23.1	28.4	28.4	48.0	68.	28.8	11.1	8.7	9.1	38.6	30.2	39.1
29.	48.0	14.3	12.5	24.8	29.8	26.1	51.6	69.	28.7	10.6	8.2	15.0	36.9	28.6	52.3
30.	47.8	14.7	13.7	24.7	30.8	28.7	51.6	70.	28.5	10.8	8.0	14.4	37.8	28.1	50.6
31.	47.7	14.0	12.7	25.4	29.4	26.6	53.3	71.	28.0	11.7	9.1	13.0	42.3	32.5	46.4
32.	46.6	15.0	14.4	23.4	32.2	30.9	50.2	72.	27.0	9.6	7.3	12.5	35.5	27.0	46.3
33.	44.2	13.3	13.5	21.0	30.1	30.6	47.6	73.	26.4	10.0	7.0	14.0	37.9	26.5	53.0
34.	43.7	11.9	13.4	20.0	27.3	30.7	45.8	74.	26.1	11.0	7.2	13.8	42.2	38.7	55.0
35.	43.0	12.3	12.0	22.8	28.6	27.9	53.0	75.	26.0	9.7	9.4	11.8	37.2	36.2	45.4
36.	42.7	13.5	11.7	22.1	31.6	27.4	51.8	76.	25.3	9.4	7.3	13.3	37.1	28.8	52.5
37.	42.3	11.1	13.5	18.2	26.2	31.9	43.0	77.	25.0	10.7	7.0	12.8	42.8	28.0	51.3
38.	41.5	11.5	11.4	19.6	27.7	27.5	47.2	78.	24.6	9.5	8.4	10.9	38.8	34.1	44.3
39.	41.5	12.3	12.4	21.3	29.6	29.9	51.4	79.	24.5	10.5	7.0	13.0	42.9	28.5	53.1
40.	41.0	10.9	12.8	18.7	26.6	31.2	45.6	80.	24.3	11.5	9.2	10.3	47.3	27.9	42.4

2. Plesiotype, Smith (1932: pl. 61, fig. 1), USNM 75286a.
3. Holotype, *C. ligatus* Smith (1932: pl. 47, figs. 1-3), USNM 74985a.
6. Paratype, *C. consanguineus* Smith (1932: pl. 46, fig. 3), USNM 74983b.
7. Holotype, *C. consanguineus* Smith (1932: pl. 46, figs. 1, 2), USNM 74983a.
11. Holotype, *C. spencei* Smith (1932: pl. 78, figs. 1, 2), USNM 75309a.
13. Holotype, *C. ornatus* Smith (1932: pl. 46, figs. 14, 15), USNM 74984a.
15. Plesiotype, Smith (1932: pl. 61, figs. 2-1), USNM 75286b.
26. Plesiotype, Smith (1932: pl. 61, figs. 5-7), USNM 55286c.
40. Holotype, Smith (1932: pl. 1, figs. 9-11), USNM 75216a.
45. Paratype, *C. ligatus* Smith (1932: pl. 47, figs. 4, 5), USNM 74985b.
46. Paratype, *C. spencei* Smith (1932: pl. 78, figs. 5, 6), USNM 75309c.
59. Paratype, *C. ligatus* Smith (1932: pl. 47, figs. 6-8), USNM 74985c.
61. Plesiotype, Smith (1932: pl. 61, figs. 8, 9), USNM 75286d.
63. Paratype, Smith (1932: pl. 1, figs. 12-14), USNM 75216b.
65. Paratype, *C. spencei* Smith (1932: pl. 78, figs. 7, 8), USNM 75309d.
78. Paratype, *C. ornatus* Smith (1932: pl. 46, figs. 16-18), USNM 74984b.
80. Paratype, *C. spencei* Smith (1932: pl. 78, figs. 9, 10), USNM 75309c.

TABLE 33. *Continued.*

	D	W	H	U	W/D	H/D	U/D		D	W	H	U	W/D	H/D	U/D
81.	23.7	10.0	7.2	10.3	42.2	30.1	43.5	95.	14.3	7.0	4.6	5.7	48.9	32.2	39.8
82.	23.0	10.0	8.0	9.4	43.5	34.8	40.7	96.	14.3	7.8	5.1	6.4	54.5	35.6	44.7
83.	22.8	9.4	6.5	11.1	41.2	28.5	48.7	97.	13.8	8.0	4.7	6.5	58.0	34.0	47.1
84.	22.7	9.8	6.5	10.7	43.2	28.6	47.2	98.	13.5	7.0	5.0	5.2	56.0	37.0	38.5
85.	22.7	9.3	6.5	11.2	40.9	28.6	49.3	99.	13.0	4.0	4.0	6.7	30.8	30.8	51.5
86.	22.2	11.8	6.7	10.2	53.3	30.2	46.0	100.	11.4	4.9	3.8	4.5	43.0	33.3	39.4
87.	21.9	9.4	8.3	8.5	42.9	37.8	38.8	101.	10.6	6.6	3.7	4.8	62.2	34.9	45.3
88.	21.8	10.4	6.2	10.0	47.7	28.4	45.9	102.	9.7	5.5	3.5	3.7	56.7	36.1	37.8
89.	20.5	9.8	6.0	10.8	47.8	29.3	52.7	103.	9.5	5.5	3.5	4.1	58.0	36.9	43.2
90.	19.3	9.2	5.8	9.3	47.6	30.1	48.2	104.	8.8	6.1	3.2	3.5	69.2	36.4	39.8
91.	18.7	9.5	7.2	8.2	50.8	38.4	43.8	105.	8.4	5.1	3.0	2.8	60.7	35.7	33.3
92.	17.0	8.8	4.7	8.4	51.7	27.6	49.4	106.	8.0	4.5	2.8	3.6	56.3	35.1	45.0
93.	15.8	7.3	4.3	7.3	46.2	27.2	46.2	107.	7.2	4.4	2.5	2.3	61.1	34.7	32.0
94.	15.3	7.5	5.2	6.7	49.0	34.0	33.8								

81. Paratype, Smith (1932: pl. 61, figs. 11–13), USNM 75286f.
82. Paratype, *C. spencei* Smith (1932: pl. 78, figs. 13–16), USNM 75309g.
87. Paratype, *C. consanguineus* Smith (1932: pl. 46, figs. 5, 6), USNM 74983c.
91. Paratype, *C. spencei* Smith (1932: pl. 78, figs. 11, 12), USNM 75309f.
94. Paratype, Smith (1932: pl. 61, figs. 14, 15), USNM 75286g.
96. Paratype, Smith (1932: pl. 72, figs. 22–24), USNM 75286q.
97. Paratype, *C. spencei* Smith (1932: pl. 77, figs. 1–4), USNM 75309h.
98. Paratype, *C. consanguineus* Smith (1932: pl. 46, figs. 7–9), USNM 74983d.
99. Holotype, *C. minimus* Smith (1932: pl. 47, figs. 9, 10), USNM 74986.
100. Paratype, *C. ornatus* Smith (1932: pl. 46, figs. 19, 20), USNM 74984c.
101. Paratype, *C. spencei* Smith (1932: pl. 77, figs. 5–8), USNM 75309i.
102. Paratype, Smith (1932: pl. 61, figs. 16–18), USNM 75286h.
103. Paratype, Smith (1932: pl. 72, figs. 19–21), USNM 75286p.
104. Paratype, *C. spencei* Smith (1932: pl. 77, figs. 9012), USNM 75309k.
105. Paratype, *C. consanguineus* Smith (1932: pl. 46, figs. 10–13), USNM 74983e.
106. Paratype, Smith (1932: pl. 72, figs. 16–18), USNM 75309o.
107. Paratype, *C. spencei* Smith (1932: pl. 77, figs. 13–15), USNM 75309l.

All other specimens are from the *Columbites* fauna of Paris Canyon, Montpelier Canyon, and Hot Springs, around north end of Bear Lake, southeast Idaho.

figs. 13–18; Diener, 1915: 112; C. Renz, 1928: 155; Renz and Renz, 1947: 59; Renz and Renz, 1948: 19, pl. 11, figs. 3–3a, 4–4a, 5–5a, 6–6a. *Subcolumbites europaeus*,—Spath, 1934: 204, pl. 12, figs. 6a, b, text-fig. 62c.

Columbites europaeus-perrini-smithi Renz and Renz, 1947: 59; Renz and Renz, 1948: 20, pl. 11, figs. 1–1b, 2–2b.

Columbites mirditensis Arthaber, 1911: 263, pl. 24(8), figs. 2, 3, 4; Diener, 1915: 112; C. Renz, 1928: 155; Renz and Renz, 1947: 59; Renz and Renz, 1948: 21.

Subcolumbites mirditensis,—Spath, 1934: 205.

Subcolumbites kwangsiamis Chao, 1959: 128, 304, pl. 30, figs. 14–17, text-fig. 41c.

Columbites asymmetricus Chao, 1959: 127, 303, pl. 30, figs. 10–13.

Subcolumbites cf. *perrinismithi*,—Bando, 1964a: 99, pl. 3, figs. 18, 19, pl. 4, fig. 3.

Arthaber (1908, 1911) had 70 specimens from the Këira, Albania, fauna that he assigned to four species of *Columbites*. Of this original collection there are avail-

able today only 16 specimens, most of which were illustrated by Arthaber. The unretouched photographs reproduced here clearly demonstrate the poor preservation of these Albanian specimens, and that Arthaber's illustrations are highly retouched.

Both Arthaber (1911) and Spath (1934) recognized the gradational nature of the "species" established for these Albanian forms. Three of these so-called species (*S. europaeus*, *S. perrinismithi*, and *S. mirditensis*) vary mainly in the degree of compression of the whorls. As the whorls become more compressed the umbilical shoulder is more rounded, as the whorls become more depressed the umbilical shoulder becomes more acutely rounded. *Subcolumbites perrinismithi* is the more compressed form, *S. mirditensis* the more

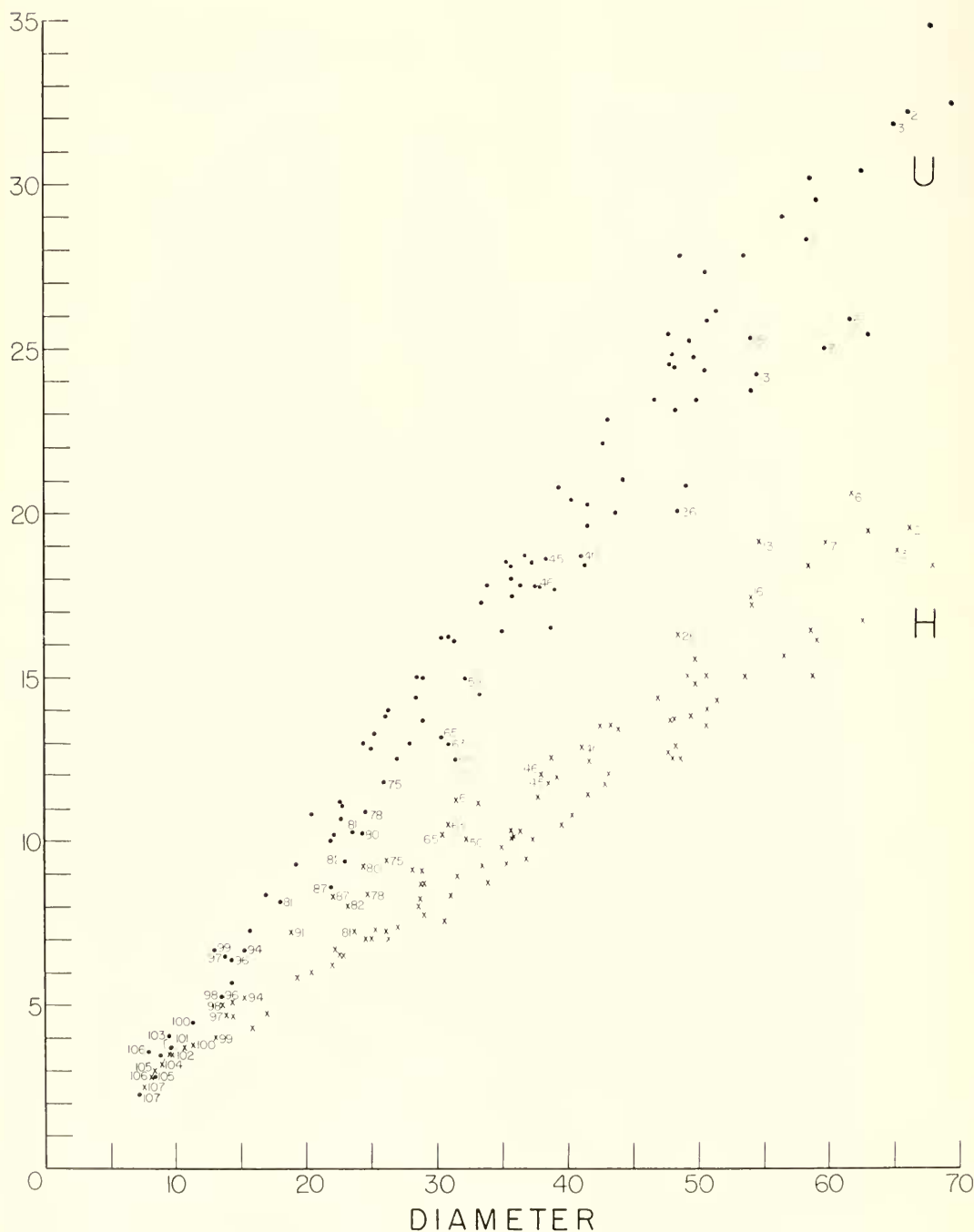


Figure 23. Variation in whorl height (H) and umbilical diameter (U) in *Columbites parisianus* Hyatt and Smith from *Columbites* Zone, Thaynes Formation, southeast Idaho. The data on this graph are from Table 33.

depressed form. Restudy of the available specimens from Këira, conspecific forms from Chios, and topotypes of the Këira forms in the British Museum (Natural History) clearly show that there is complete gradation in the degree of compression of the whorls. The measurements of the types available from Këira and Chios are given on Table 34. The sutures of *S. mirditensis* and *S. europaeus* are illustrated on Figures 24A, B.

The pattern and intensity of ornamentation is also quite variable. In terms of the forward projecting ribs, they range from the fine, regular pattern, as illustrated by *S. perrinismithi* (Pl. 3, figs. 6, 7), to one where in the adoral volutions the ribs are bunched, especially on the venter, forming chevrons (Pl. 1, figs. 7, 8).

Among the four species established by Arthaber (1908, 1911), there is one (*S. dusmani*) which is quite distinct from the other three. Arthaber had only two specimens, both of small size and poor preservation. This species differs from *S. perrinismithi*, as interpreted here, in lack of a tendency toward carination of the venter and in the more conspicuous reticulate ornamentation. I cannot agree at all that this form is "scarcely more than a variety of *S. europaeus*" (Spath, 1934: 205). This conclusion is strengthened by the discovery of better preserved conspecific forms on Chios and other species of this general ornamental pattern from Kwangsi, China, and Nevada.

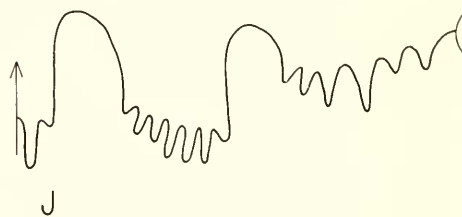
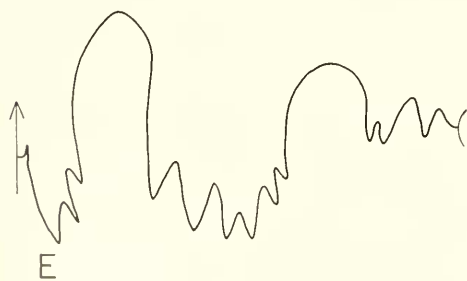
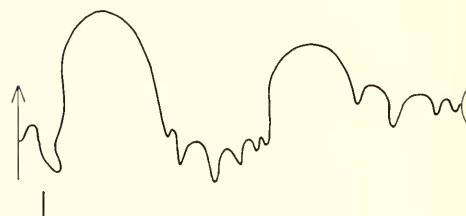
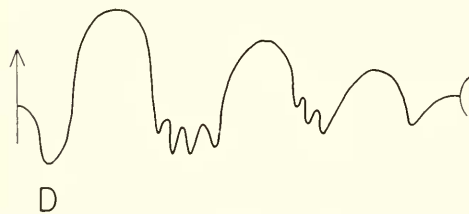
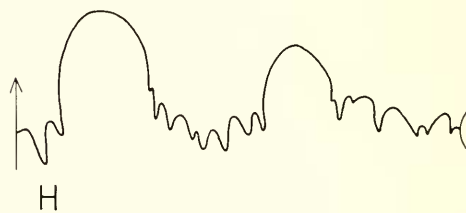
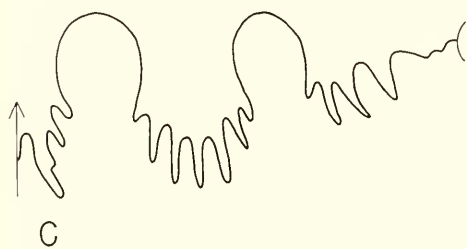
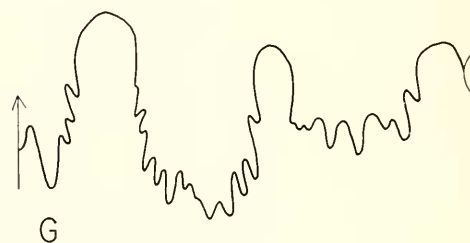
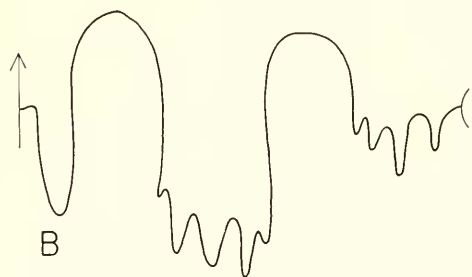
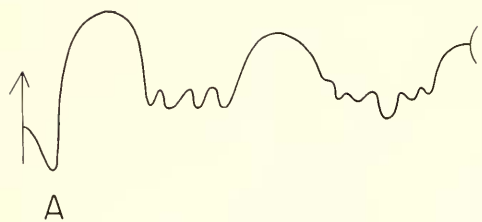
Subcolumbites kwangsiensis Chao (1959) was established for two poorly preserved specimens from Kwangsi, China. Though very poorly preserved, the whorl shape, carination of the venter, and ornamentation are like those features in *S. perrinismithi* of Albania and Chios. Chao (1959: 304) recognized the affinities of his species to the Albanian forms but concluded that the elliptical coiling of his species served to distinguish it. The so-called elliptical coiling is no more than that apparent in some of the poorly preserved Albanian speci-

TABLE 34. MEASUREMENTS OF *SUBCOLUMBITES PERRINISMITHI* (ARTHABER) FROM ALBANIA AND CHIOS.

	D	W	H	U	W/D	H/D	U/D
1.	60.4	17.5	19.0	28.7	28.9	31.5	47.5
2.	58.0	16.8	17.5	27.5	28.9	30.2	47.4
3.	55.0	17.7	17.2	23.1	32.2	31.3	42.0
4.	54.4	18.1	20.0	24.6	33.3	36.8	45.2
5.	53.7	13.0	17.4	23.8	24.2	32.4	44.3
6.	52.3	17.2?	16.6	24.2	32.9?	31.7	46.3
7.	49.3	?	14.4	22.8	?	29.2	46.2
8.	48.8	?	13.6	23.9	?	27.9	48.9
9.	47.5	?	16.0	22.0	?	33.7	46.3
10.	46.0	?	15.0	21.3	?	32.6	46.3
11.	43.5	?	14.7	20.0	?	33.8	45.9
12.	40.7	15.4	14.1	18.3	37.8	34.6	44.9
13.	37.0	?	13.0	16.3	?	35.1	44.1
14.	34.4	?	11.8	15.7	?	34.3	45.6
15.	34.3	15.1?	11.2	14.8	44.0?	32.7	43.1
16.	28.3	11.7	10.3	12.0	41.3	36.4	42.4
17.	27.3	14.1	10.1	9.7	51.6	36.9	35.5

1. Plesiotype, *Columbites europaeus* Arthaber (1911: pl. 23(7), figs. 18a, b), PIUV.
2. Plesiotype, *Columbites europaeus-perrini-smithi* Renz and Renz (1948: pl. 11, figs. 1, 1a), NHMB J13538.
3. Plesiotype, *Columbites europaeus-perrini-smithi* Renz and Renz (1948: pl. 11, figs. 2, 2a), NHMB J13539.
4. Plesiotype, *Columbites europaeus* Arthaber (1911: pl. 23(7), figs. 15a, b), PIUV.
5. Plesiotype (Arthaber, 1911: pl. 23(7), figs. 20a, b), PIUV.
6. Plesiotype, *Columbites europaeus*,—Renz and Renz (1948: pl. 11, figs. 3-3a), NHMB J13533.
7. Plesiotype, *Columbites perrini-smithi*,—Renz and Renz (1948: pl. 11, figs. 7, 7a), NHMB J13537.
8. Plesiotype, *Columbites europaeus*,—Renz and Renz (1948: pl. 11, figs. 4, 4a), NHMB J13534.
9. Paratype, *Columbites mirditensis* Arthaber (1911: pl. 24(8), figs. 3a, b), PIUV.
10. Holotype (Arthaber, 1908: pl. 12, figs. 1a-c), PIUV.
11. Plesiotype (Arthaber, 1911: pl. 23(7), figs. 19a, b), PIUV.
12. Plesiotype, *Columbites europaeus* Arthaber (1911: pl. 23(7), figs. 16a, b), PIUV.
13. Holotype, *Columbites mirditensis* Arthaber (1911: pl. 24(8), figs. 2a, b), PIUV.
14. Paratype, *Columbites mirditensis* Arthaber (1911: pl. 24(8), figs. 4a, b), PIUV.
15. Plesiotype, *Columbites europaeus*,—Renz and Renz (1948: pl. 11, figs. 5, 5a), NHMB J13535.
16. Plesiotype, *Columbites europaeus* Arthaber (1911: pl. 23(7), figs. 13a-c), PIUV.
17. Plesiotype, *Columbites europaeus*,—Renz and Renz (1948: pl. 11, figs. 6, 6a), NHMB J13536.

mens of *S. perrinismithi* (Pl. 1, figs. 3, 9). *Subcolumbites kwangsiensis* is considered to be a synonym of *S. perrinismithi*. The two specimens from Japan recorded by Bando (1964a: 99) as *Subcolumbites* cf. *perrinismithi*, though poorly preserved, are surely conspecific with this species. The



sutures of these species are shown on Figures 24A, B, E, J.

Occurrence. *Subcolumbites* faunas of Albania, Chios, Afghanistan, China, and Japan.

Repository. The following specimens are in the Paleontological Institute, Vienna: holotype *Columbites perrini-smithi* Arthaber, 1908: pl. 12(2), figs. 1a–c (Pl. 4, figs. 1, 2 of this report); topotype, *Columbites perrini-smithi* Arthaber, 1911: pl. 23(7), figs. 19a, b (Pl. 3, figs. 1–3 of this report); topotype *Columbites perrini-smithi* Arthaber, 1911: pl. 23(7), figs. 20a, b (Pl. 3, figs. 6, 7 of this report); holotype, *Columbites europaeus* Arthaber, 1908: pl. 12 (2), figs. 2a–d (Pl. 4, fig. 3 of this report); topotypes, *Columbites europaeus* Arthaber, 1911: pl. 23(7), figs. 13–18 (Pl. 1, figs. 1–9, Pl. 2, figs. 5–6 of this report); syntype, *Columbites mirditensis* Arthaber, 1911: pl. 24(8), fig. 2 (Pl. 3, figs. 8, 9 of this report); syntype, *Columbites mirditensis* Arthaber, 1911: pl. 24(8), fig. 3 (Pl. 2, figs. 7, 8 of this report); type specimen *Columbites mirditensis* var. Arthaber, 1911: pl. 24(8), fig. 4 (Pl. 3, figs. 4, 5 of this report).

The following specimens are in the Natural History Museum, Basel: plesiotype *Columbites perrini-smithi*,—Renz and Renz (1948: pl. 11, fig. 7) NHMB J13537; plesiotypes *Columbites europaeus*,—Renz and Renz (1948: pl. 11, fig. 3) NHMB J13533, (pl. 11, fig. 4) NHMB J13534, (pl. 11, fig. 5) NHMB J13535, (pl. 11, fig.

6) NHMB J13536; unfigured specimens from Maradovuno NHMB J13543, from Kephlovuno NHMB J13544; syntypes *Columbites europaeus-perrini-smithi* Renz and Renz (1948: pl. 11, fig. 1) NHMB J13538, (pl. 11, fig. 2) NHMB J13539; unfigured specimens from Maradovuno NHMB J13547, from Kephlovuno J13548; recorded specimen of *Columbites mirditensis*,—Renz and Renz (1948: 21) NHMB J13550.

The British Museum (Natural History) contains the following topotype specimens from the *Subcolumbites* fauna of Albania: *S. perrini-smithi*, C911–15, C22916–23, C22924–6; *S. europaeus*, C22890–900, C22901–10; *S. mirditensis*, C22883–6, C22887–9. Paratype from Albania MCZ 6723, from Chios MCZ 10026, specimens from Afghanistan MCZ 10138, 10146.

Subcolumbites dusmani (Arthaber)

Plate 2, figures 1–4; Text-figure 24

Columbites dusmani Arthaber, 1911: 263, pl. 24(8), figs. 1a–d; Diener, 1915: 112; Renz and Renz, 1947: 73.

Subcolumbites dusmani,—Spath, 1934: 204.

Columbites diana Renz and Renz, 1947: 59, 73; Renz and Renz, 1948: 21, pl. 10, figs. 6–6b, 7–7b.

Columbites diana var. *involuta* Renz and Renz, 1947: 59.

Columbites diana var. *evoluta* Renz and Renz, 1948: 22.

Columbites gracco-americanus Renz and Renz, 1947: 59, 73; C. Renz, 1947: 176; Renz and Renz, 1948: 27, pl. 10, figs. 4–4b.

←

Figure 24. Diagrammatic representation of the sutures of species of *Subcolumbites*. A, syntype of *Columbites mirditensis* Arthaber (1911: pl. 24(8), figs. 2a–c; Pl. 3, figs. 8, 9 of this report), at a diameter of 25 mm; B, *Columbites europaeus* Arthaber (1911: pl. 23(7), figs. 15a–c; Pl. 1, figs. 1, 2 of this report), at a diameter of 35 mm; C, paratype of *Columbites diana* Renz and Renz (1948: pl. 10, fig. 7b), at a diameter of 25 mm; D, paratype of *Fengshanites robustus* Chao (1959: 129, fig. 42a), at a diameter of approximately 30 mm; E, holotype of *Subcolumbites kwangsiensis* Chao (1959: 128, fig. 41c), at a diameter of approximately 40 mm; F, *Subcolumbites multiformis* Kiparisova (1947: 144, fig. 32), at a diameter of 31 mm; G, *Subcolumbites multiformis* Kiparisova (1947: 144, fig. 31), at a diameter of approximately 15 mm; H, paratype of *Subcolumbites americanus* n. sp. (MCZ 9435, Pl. 30, fig. 8), at a diameter of 31 mm; I, paratype of *Subcolumbites americanus* n. sp. (MCZ 9438, Pl. 30 figs. 13, 14), at a diameter of 14 mm; J, syntype of *Columbites europaeus-perrini-smithi* Renz and Renz (1948: pl. 11, fig. 2b), at a diameter of approximately 40 mm.

Specimens of figures A, B from *Subcolumbites* fauna of Albania; C, J from same horizon on Chios; D, E from same horizon in Kwangsi, China; F, G from same horizon in the Primorye Region, eastern Siberia; H, I from same horizon in Tobin Formation, Nevada.

Columbites aithaliae Renz and Renz, 1947: 59, 74; Renz and Renz, 1948: 28, pl. 10, figs. 3-3b, 5-5b.

Columbites parisianus,—C. Renz, 1945: 301; C. Renz, 1947: 176; Renz and Renz, 1947: 59; Renz and Renz, 1948: 22, pl. 11, figs. 8-8b.

Columbites spencei Smith var. *chiotica* Renz and Renz, 1947: 59, 73; Renz and Renz, 1948: 22, pl. 3, figs. 7-7b.

The two syntypes of this species are relatively small specimens preserved only on one side and that only modestly well. These two specimens differ from *S. perrin-smithi* in the strong reticulate ornamentation and the lack of any tendency toward carination. The reticulate ornamentation is more conspicuous on one syntype (Pl. 2, figs. 1, 2) than on the other (Pl. 2, figs. 3, 4) where it is only faintly visible.

The *Subcolumbites* fauna of Chios has yielded a number of what are believed to be conspecific forms. Renz and Renz (1948) had nine specimens of the morphological type of *S. dusmani* which they placed in five different species. Three of these species were based on one specimen each, one species was based on two specimens, and one species on four specimens. The large number of species introduced by Renz and Renz for this group reflects pronounced morphological differences from one specimen to the other. Whereas the sample comprising all these species from Chios is extremely small, a case can be made that the patterns of morphological differences are most likely gradational and that we are dealing with a single variable species. Likewise, study of large populations of other species of a similar morphological type, *Columbites parisianus* for instance, offers an insight into the potential variability that is possible in some of these Scythian ammonoids.

The holotype of *Columbites dianae* Renz and Renz is a large well preserved specimen clearly conspecific with *S. dusmani*. Renz and Renz (1948: 21) did not consider Arthaber's two syntypes of *S. dusmani* to be conspecific. On this basis they designated one of the specimens (Arthaber,

1911: pl. 24(8), figs. 1a, b; Pl. 2, figs. 3, 4 of this report) as the type (lectotype) of *S. dusmani* and considered the other specimen as conspecific with their *C. dianae* from Chios. The separation of Arthaber's two syntypes of *S. dusmani* cannot be accepted. The principal difference in these two specimens is in the expression of the reticulate ornamentation which is most pronounced on the ventral region. The specimen which Renz and Renz (1948: 21) designated as the type of *S. dusmani* is very badly weathered over most of the the venter; however, small traces of the shell are present and these clearly show a nice reticulate pattern. There is no justification for separating these two specimens into different species.

In addition to the well developed reticulate pattern on the holotype of *Columbites dianae*, there is on the adoral quarter volution a bundling of the prosiradiate ribs and a decrease in the strigations. In *Columbites aithaliae* there is a very pronounced bundling of the ribs producing strong prosiradiate folds over the ventral regions and extending half way up the flanks on the last quarter volutions. This change in ornamental patterns takes place at an approximate diameter of 28.0 mm, whereas in *Columbites dianae* this change takes place at approximately 70 mm in diameter.

Columbites graecoamericanus Renz and Renz has the coarse bundled ribs developed on the whole adoral volution. *Columbites spencei* var. *chiotica* Renz and Renz is nothing more than a sparsely ribbed *graecoamericanus*. Each species was established on a single specimen. Finally, the *Columbites parisianus* of Renz and Renz is based on a small inner whorl of *C. dianae*. The sutures of these species are all of the same basic pattern and vary only in details (Fig. 24C).

The few specimens that are available suggest that the differences in ornament pattern are most probably a reflection of differences in ontogenetic growth, that is,

TABLE 35. MEASUREMENTS OF *SUBCOLUMBITES DUSMANI* (ARTHABER) FROM ALBANIA AND CHIOS.

	D	W	H	U	W/D	H/D	U/D
1.	74.2	25.5	31.5	21.7	34.4	42.5	29.2
2.	54.8	22.5	19.3	21.5	41.1	35.2	39.2
3.	51.3	17.8	17.7	20.7	34.7	34.5	40.4
4.	38.8	?	14.5	15.3	?	37.4	39.4
5.	37.7	?	14.5	14.9	?	38.5	39.5
6.	35.7?	?	15.3	10.4	?	59.5?	29.1?
7.	33.0	25.4	12.7	10.8	76.9	38.5	32.7
8.	26.6	14.8	15.2	10.0	55.6	57.1	37.6
9.	23.7	11.6	7.6	11.7	48.9	32.1	49.4

1. Holotype, *Columbites dianae* Renz and Renz (1948: pl. 10, fig. 6), NHMB J13540.
2. Holotype, *Columbites graeco-americanus* Renz and Renz (1948: pl. 10, figs. 4–4b), NHMB J13564.
3. Plesiotype, *Columbites spencei* var. *chiotica* Renz and Renz (1948: pl. 3, figs. 7–7b), NHMB J13553.
4. Syntype (Arthaber, 1911: pl. 24(8), figs. 1a, b), PIUV.
5. Syntype (Arthaber, 1911: pl. 24(8), figs. 1c, d), PIUV.
6. Holotype, *Columbites aithaliae* Renz and Renz (1948: pl. 10, figs. 5–5b), NHMB J13568.
7. Paratype, *Columbites aithaliae* Renz and Renz (1948: pl. 10, figs. 3–3b), NHMB J13570.
8. Paratype, *Columbites dianae* Renz and Renz (1948: pl. 10, fig. 7), NHMB J13541.
9. Plesiotype, *Columbites parisianus*,—Renz and Renz (1948: pl. 11, figs. 8–8b), NHMB J13542.

different rates of appearance of the successive stages. This type of variability in growth patterns is well illustrated in *Columbites parisianus* where we have a large population to work with and can document all of the transitional forms convincingly. It is largely on the basis of my studies of *Columbites parisianus* that I have come to the conclusion that these five species from Chios of Renz and Renz are all conspecific. Measurements of these species and of Arthaber's are given on Table 35. This interpretation, of course, needs confirmation, which can only be done when additional collections of these species are assembled.

Subcolumbites dusmani can be easily distinguished from *S. perrinismithi* in the lack of any tendency toward carination of the venter and in the general greater development of the reticulate ornamentation. *Subcolumbites robustus* Chao has a much more depressed whorl and low, broad, radial folds on the flanks, as does *S. ameri-*

canus from Nevada. *Subcolumbites multi-formis* is also a species with a depressed whorl section but has no lateral nodes or folds.

Occurrence. *Subcolumbites* fauna of Albania and Chios.

Repository. Arthaber's two syntypes are in the Paleontological Institute, University of Vienna. The Chios fauna studied by Renz and Renz (1948) is in the Natural History Museum, Basel—holotype, *Columbites dianae* Renz and Renz (1948: pl. 10, fig. 6) NHMB J13540; paratype (pl. 10, fig. 7) NHMB J13541; unfigured paratypes NHMB J13551; holotype, *Columbites graecoamericanus* Renz and Renz (1948: pl. 10, fig. 4) NHMB J13564; unfigured paratypes J13565; holotype, *Columbites aithaliae* Renz and Renz (1948: pl. 10, fig. 5) NHMB J13568; paratype (pl. 10, fig. 3) NHMB J13570; unfigured paratypes from Maradovuno NHMB J13571, from Kephlovuno NHMB J13572; plesiotype, *Columbites parisianus*,—Renz and Renz (1948: pl. 11, fig. 8) NHMB J13542; unfigured specimens NHMB J13552; type specimen, *Columbites spencei* var. *chiotica* Renz and Renz (1948: pl. 3, fig. 7) NHMB J13553.

Subcolumbites robustus (Chao)

Text-figure 24

Fengshanites robustus Chao, 1950: 4, pl. 1, figs. 2, 3; Chao, 1959: 129, 305, pl. 8, figs. 1, 2, pl. 29, figs. 21–22, text-fig. 42a.

This species is of the same general morphological type as *S. americanus* from Nevada. Although the species is based on only two specimens, its distinctness is readily apparent. The whorls are more inflated and depressed than in *S. dusmani*. In addition, there are low irregular folds on the flanks. The suture is illustrated on Figure 24D.

Occurrence. 1.5 km north of Yali, Fengshan district, associated with *Dagnoceras* and *Hellenites* (Chao collection 546), Kwangsi, China.

Subcolumbites multiformis Kiparisova
Text-figure 24

Subcolumbites multiformis Kiparisova, 1947: 144, pl. 32, figs. 8–11, text-figs. 31–34; Kiparisova and Krishtofovich, 1954: 22, pl. 13, figs. 1–3; Kiparisova, 1961: 121, pl. 27, figs. 1–7, text-fig. 82–88.

Subcolumbites solitus Kiparisova, 1961: 123, pl. 26, figs. 4, 5, text-fig. 89, 90.

Subcolumbites anomalus Kiparisova, 1961: 123, pl. 26, figs. 6, 7, text-fig. 91.

Kiparisova (1961) had 35 specimens from what I judge to be the same horizon and locality at Cape Zhitkov, Primorye Region, eastern Siberia. Of these specimens, she placed 25 in *S. multiformis*, first described by her in 1947; seven specimens were placed in a second species, *S. solitus*; and three specimens were placed in another new species, *S. anomalus*. The latter two species were distinguished on the basis of slightly greater whorl depression and minor differences in the nature of the ornamentations. The suture, however, in all three species is essentially the same (Fig. 24F, G).

Unfortunately, Kiparisova supplied measurements for only 10 specimens of her three species of *Subcolumbites*; these data are tabulated on Table 36. On the basis of these data, there does not appear to be any real difference in relative whorl proportions. Kiparisova recognized that her *S. multiformis* was a highly variable form and that nearly all her specimens of *Subcolumbites* were juvenile specimens. This does not appear to be any justification for recognizing any more than one species of *Subcolumbites* within this faunal group.

Subcolumbites multiformis does not show any particularly close relationship to the group of *S. perrinismithi* or *S. dusmani*, but is very similar to *S. robustus* from Kwangsi, China, and *S. americanus* from western United States. The similarity to the latter two species is expressed in the depressed whorl section, reticulate ornamentation, and in the suture. It differs from these two species, however, in the lack of any lateral folds or nodes.

TABLE 36. MEASUREMENTS OF *SUBCOLUMBITES MULTIFORMIS*, *S. SOLITUS*, AND *S. ANOMALUS* FROM UPPER SCYTHIAN BEDS, PRIMORYE REGION, EASTERN SIBERIA.

	D	W	H	U	W/D	H/D	U/D
1.	45.0	24.8	15.3	18.9	55.0	34.0	42.0
2.	32.0	22.7	10.9	11.8	71.0	34.0	37.0
3.	29.0	18.9	9.9	11.3	65.0	34.0	39.0
4.	24.5	14.5	9.2	8.3	59.0	38.0	34.0
5.	17.0	11.9	5.4	6.5	70.0	32.0	38.0
6.	16.5	14.9	5.0	5.0	90.0	30.0	30.0
7.	16.0	13.4	3.5	5.9	84.0	22.0	37.0
8.	16.0	10.1	5.0	5.9	63.0	31.0	37.0
9.	11.5	10.4	3.0	4.5	90.0	26.0	39.0
10.	8.0	8.6	2.6	2.6	108.0	33.0	33.0

1–3, 5, 7, 9. *Subcolumbites multiformis*, data from Kiparisova, 1961: 121.

4, 8. *Subcolumbites solitus*, data from Kiparisova, 1961: 123.

6, 10. *Subcolumbites anomalus*, data from Kiparisova, 1961: 124.

Occurrence. *Subcolumbites* fauna at Cape Zhitkov, Primorye Region, eastern Siberia.

Subcolumbites americanus n. sp.

Plate 30, figures 1–14; Text-figure 24

This is one of the common ammonites in the Tobin Formation fauna from Nevada. The collections contain a large number of well preserved but mainly fragmentary specimens. However, ten specimens are sufficiently complete to yield measurements (Table 37).

The conch is evolute, robust, and with a characteristic pattern of ornamentation. The venter is arched and grades imperceptibly onto convex lateral areas. The umbilical shoulders are sharply rounded and the umbilical wall steep but not vertical. The conch bears low nodes situated just on the ventral side of the umbilical shoulder. In addition, there are prominent striae of growth, often bundled, which are retriradiate on the umbilical wall and prosiradiate on the lateral areas, completely crossing the venter. There are also periodic constrictions and fine strigation.

The suture is shown on Figures 24H, I.

Clearly, this species is closely allied to *S. multiformis* from the Primorye Region and *S. robustus* from Kwangsi, China.

TABLE 37. MEASUREMENTS OF *SUBCOLUMBITES AMERICANUS* N. SP. FROM THE TOBIN FORMATION OF NEVADA.

	D	W	H	U	W/D	H/D	U/D
1.	47.3	25.0?	19.3	16.3	52.9?	40.8	34.5
2.	47.0	?	17.1	16.4	?	36.4	34.8
3.	42.2	20.8?	16.8	15.6	49.3?	39.8	36.9
4.	35.2	?	12.0	13.2	?	34.1	37.5
5.	31.8	16.1	12.6	9.7	50.6	39.6	30.5
6.	31.1	16.7	11.4	10.2	53.7	36.7	22.5?
7.	20.4	11.8?	7.3	7.0?	57.8	35.8	34.3?
8.	20.1	11.2	7.6	6.6	55.7	37.8	32.8
9.	20.1	10.3	7.8	5.7	51.2	38.8	28.4
10.	17.0	10.8	6.5	5.5	63.5	38.2	32.4

1. Holotype, MCZ 9430 (Pl. 30, figs. 1, 2).
2. Paratype, MCZ 9431 (Pl. 30, fig. 3).
3. Paratype, MCZ 9492.
4. Paratype, MCZ 9433 (Pl. 30, fig. 5).
5. Paratype, MCZ 9434 (Pl. 30, figs. 6, 7).
6. Paratype, MCZ 9435 (Pl. 30, fig. 8).
7. Paratype, MCZ 9436 (Pl. 30, figs. 9, 10).
8. Paratype, MCZ 9432 (Pl. 30, fig. 4).
9. Paratype, MCZ 9437 (Pl. 30, figs. 11, 12).
10. Paratype, MCZ 9438 (Pl. 30, figs. 13, 14).

Occurrence. Basal part of Tobin Formation, USGS locality M2562, Pershing County, Nevada; south tip of Tobin Range, Cain Mountain 1:62,500 quad., center NW $\frac{1}{4}$ sec. 9, T. 26N, R. 39E, 5,500 ft. S, 27.5 ft. W of elevation point 5088 on range crest.

Repository. Holotype (Pl. 30, figs. 1, 2) MCZ 9430; figured paratypes (Pl. 30, fig. 3) MCZ 9431, (Pl. 30, fig. 4) MCZ 9432, (Pl. 30, fig. 5) MCZ 9433, (Pl. 30, figs. 6, 7) MCZ 9434, (Pl. 30, fig. 8) MCZ 9435, (Pl. 30, figs. 9, 10) MCZ 9436, (Pl. 30, figs. 11, 12) MCZ 9437, (Pl. 30, figs. 13, 14) MCZ 9438; unfigured paratypes MCZ 9492.

Genus *Paradinarites* Chao, 1950

Type species, *Paradinarites suni* Chao, 1950
Paradinarites suni Chao

Text-figure 21

Paradinarites suni Chao, 1950: 6, pl. 1, figs. 7a, b, text-fig. 4; Chao, 1959: 98, 330, pl. 41, figs. 9–12.

Chao (1959: 331) recognized that this new genus and species was quite similar to "*Columbites*" in conch form and gross aspect of the suture but considered the goniatitic character of the lobes to indicate

affinity with the dinaritids. The general shape of the conch is that of a *Subcolumbites* but lacks strigations. The suture (Fig. 21C), also, with its large first lateral lobe is columbitid in plan and, in fact, quite like the suture of *Procolumbites karataucikus* Astakhova (1960a, b) from the upper Scythian Formation of the Mangyshlak Peninsula. The species is known from only two not very well preserved specimens but on the basis of the data available it clearly appears to be a columbitid.

Occurrence. *Subcolumbites* fauna (Chao collection 610), Kwangsi, China.

Genus *Pseudoceltites* Hyatt, 1900

Type species, *Celtites multiplicatus* Waagen, 1895

Evolute, ribbed ammonites of rather simple design are very common in mid-Scythian formations. This has led to a proliferation of specific and generic names, the relationships of which are seldom understood or appreciated. The type specimen of *Celtites multiplicatus* is a poorly preserved specimen from the Upper Ceratite Limestone of the Salt Range (Pl. 27, figs. 5, 6). *Celtites armatus* Waagen (1895: 75, pl. 7, figs. 1, 7), the type species of *Kashmirites* Diener (1913) is clearly a synonym of *Celtites multiplicatus* Waagen (Pl. 27, figs. 7–10). Spath (1930: 35) introduced the name *Anakashmirites* (type species *Danubites nivalis* Diener, 1897: 51, pl. 15, figs. 17–19) for ammonoids not too different in appearance from *Celtites multiplicatus*. Examination of the Salt Range, Himalayan, and Timor specimens that have been assigned to one or more of these three genera by Waagen (1895), Diener (1897, 1909, 1913), Welter (1922), and Spath (1930, 1934) show that the ornamental pattern is highly variable. It is in the suture pattern that one can readily separate *Pseudoceltites* and *Anakashmirites*. The former genus has a very reduced second lateral lobe that rests on or near the umbilical shoulder, whereas in

Anakashmirites there is a “normal” second lateral lobe and generally an auxiliary lobe at or near the umbilical shoulder.

As mentioned above, the type species is from the Upper Ceratite Limestone of the Salt Range, West Pakistan. In the upper part of the Scythian, three species are recognized: one (*cheneyi*) from the *Columbites* fauna of southeastern Idaho, the second (*nevadi*) from the Upper Thaynes Formation, western Utah, and the third (*dolnapaensis*) from the upper Scythian formation of the Mangyshlak Peninsula.

This genus is grouped here with the columbitids on the basis of the gross aspect of the conch and especially the basic pattern of the suture. In these aspects this genus shows similarities to such columbitids as *Columbites* and *Procolumbites*.

Pseudoceltites cheneyi n. sp.
Plate 44, figures 4–10; Text-figure 25

A number of exposures of the *Columbites* fauna of the Thaynes Formation in southeastern Idaho have yielded approximately 50 generally well-preserved specimens of this distinctive species. The conch is evolute and compressed. Measurements on 15 well-preserved specimens from one horizon and locality are given on Table 38. As can be readily seen, there is very little variation in relative thickness and height of the whorls or in umbilical diameter. The lateral areas of the whorls are flattened and slightly convergent; the venter is broad and arched. The ventral shoulder is broadly rounded, and the umbilical shoulder is more abruptly rounded with a short, steep umbilical wall. The umbilicus is broad and shallow.

TABLE 38. MEASUREMENTS OF *PSEUDOCELTITES CHENEYI* N. SP. FROM THE *COLUMBITES* FAUNA OF DRANEY CREEK, SOUTHEASTERN IDAHO. THE WIDTH DIMENSION INCLUDES THE LATERAL RIBS.

	D	W	H	U	W/D	H/D	U/D
1.	29.2	8.4	9.6	12.0	28.8	32.9	41.1
2.	29.0	?	10.0	12.1	?	47.8	57.9
3.	27.8	8.6	9.8	12.1	30.9	35.3	43.5
4.	27.5	7.6 ²	10.0	10.0	27.6 ²	36.4	36.4
5.	26.5	7.8	7.6	11.6	29.4	28.7	43.8
6.	26.0	8.0	9.6	9.2	30.8	36.9	35.4
7.	25.7	7.8	9.4	9.1	30.4	36.6	35.4
8.	22.7	7.4	7.8	9.0	32.6	34.4	39.6
9.	21.7	7.3	7.5	9.6	33.6	34.6	44.2
10.	21.4	7.0	6.9	8.3	32.7	32.2	38.8
11.	20.1	7.4	6.9	8.5	36.8	34.3	42.3
12.	20.1	7.5	6.5	9.2	37.3	32.3	45.8
13.	16.6	6.5	5.7	6.8	39.2	34.3	40.9
14.	14.0	6.4	4.5	5.3	45.7	32.1	37.9
15.	13.0	5.1	4.6	4.9	39.2	35.4	37.7

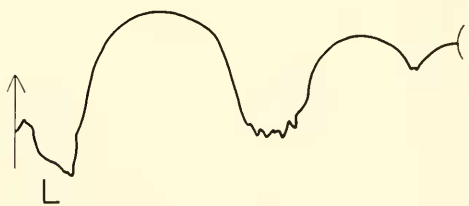
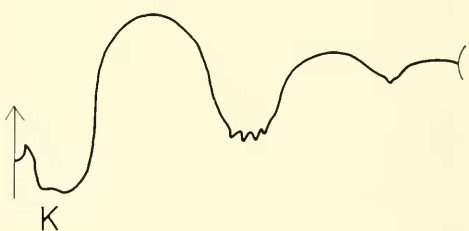
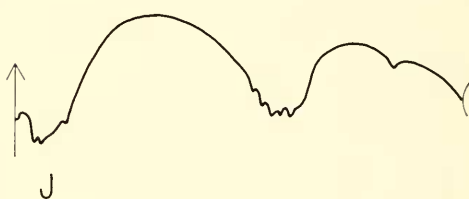
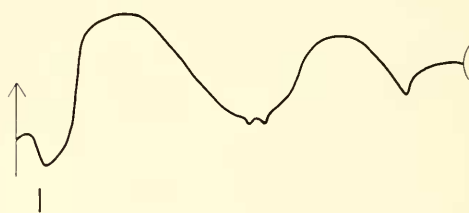
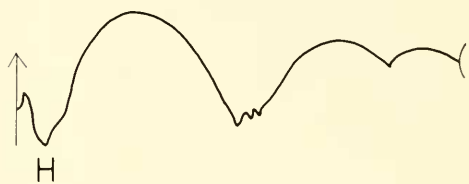
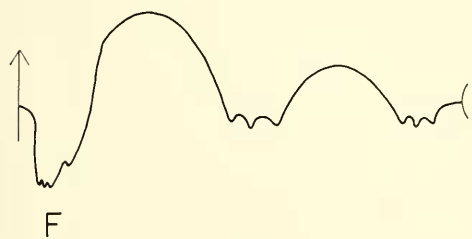
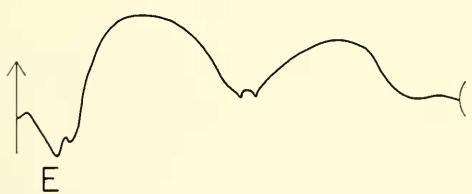
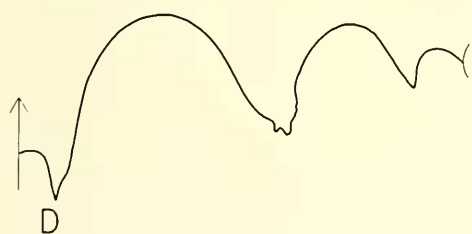
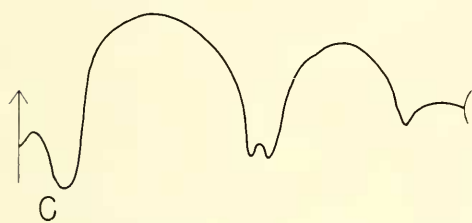
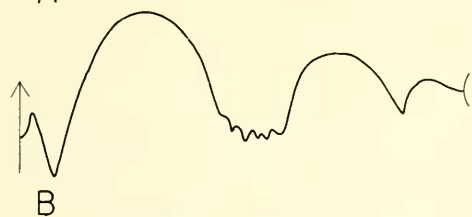
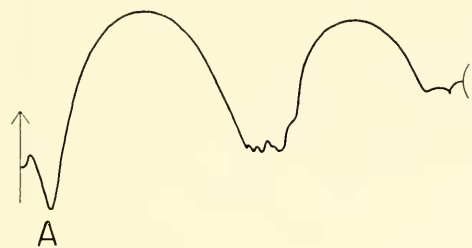
The lateral areas bear straight prosirradiate ribs that expand slightly toward the ventral shoulder where they project slightly forward. The ribs do not extend on to the venter, which is smooth except for growth lines and occasional constrictions which join the interrib areas from the opposite flanks. There are approximately 20 such ribs on the outer volution. There is some variation in the spacing of the ribs and in the relative strength or prominence of the ribs, but this variation is very slight and appears to be of no significance.

The suture consists of two rounded lateral saddles, a prominent first lateral lobe, with some denticulations, and a small, generally pointed second lateral lobe on the umbilical shoulder. The variation in the shape and proportions of the sutural elements is quite spectacular (Fig. 25).

→

Figure 25. Diagrammatic representation of the sutures of *Pseudoceltites cheneyi* n. sp. A, at a diameter of 13 mm (MCZ 9507); B, at a diameter of 17 mm (MCZ 9508); C, at a diameter of 20 mm (USNM 153074); D, at a diameter of 17 mm (MCZ 9503, Pl. 44, fig. 4); E, at a diameter of 20 mm (USNM 153075); F, at a diameter of 17 mm (USNM 153076); G, at a diameter of 16 mm (WSU); H, at a diameter of 15 mm (MCZ 9509); I, at a diameter of 14 mm (MCZ 9506); J, at a diameter of 17 mm (USNM 153077); K, at a diameter of 20 mm (USNM 153073, Pl. 44, figs. 8, 9), holotype; L, at a diameter of 17 mm (MCZ 9574).

All specimens from *Columbites* fauna, Thaynes Formation, southeastern Idaho; specimens A, B, D, H, I, J, and L are from Hot Springs; C, E, F, G, and K from Draney Creek.



The variation as illustrated by these 12 sutures should be sobering to those who tend to erect species on minor differences in the suture.

The type specimen of *Celtites multiplicatus* Waagen is a weathered specimen, in which only the outer volution is present; the inner whorls are completely weathered out (Pl. 27, figs. 5, 6). Waagen's illustration (1895: pl. 7, fig. 2) is highly restored and actually misleading. Even though the preservation of the Salt Range specimen leaves much to be desired, it is morphologically very similar to *Pseudoceltites cheneyi*. The Idaho species differs in its prosiradiate ribs rather than the radial ribs of *P. multiplicatus*. Waagen mentions slight nodes on the umbilical and ventral shoulders associated with the ribs; these nodes, however, are not present on the type specimen. The basic pattern of the suture of these two species is the same (Fig. 25). *Celtites multiplicatus* came from the Upper Ceratite Limestone of the Salt Range, which is mid-Scythian in age. The present species is from the *Columbites* Zone.

Occurrence. Middle shale member of Thaynes Formation, *Columbites* fauna, along Draney Creek, Stewart Flat, Quadrangle (USGS locality M98); and in Montpelier Canyon, Hot Springs, and Paris Canyon, all in the Bear Lake region of southeastern Idaho.

Repository. Holotype USNM 153073 (Pl. 44, figs. 8, 9); figured paratypes, MCZ 9503 (Pl. 44, fig. 4), MCZ 9504 (Pl. 44, fig. 5), MCZ 9505 (Pl. 44, figs. 6, 7), MCZ 9506 (Pl. 44, fig. 10); suture specimens MCZ 9507 (Fig. 25A), MCZ 9508 (Fig. 25B), USNM 153074 (Fig. 25C), MCZ 9503 (Fig. 25D), USNM 153075 (Fig. 25E), USNM 153076 (Fig. 25F), Department of Geology, Washington State University (Fig. 25G), MCZ 9509 (Fig. 25H), MCZ 9506 (Fig. 25I), USNM 153077 (Fig. 25J), USNM 153073 (Fig. 25K), MCZ 9574 (Fig. 25L); unfigured specimens from Hot Springs, southeast Idaho MCZ

9510; unfigured specimens from Montpelier Canyon, southeast Idaho MCZ 9511.

Pseudoceltites dolnapaensis Kiparisova
Text-figure 21

Columbites dolnapaensis Kiparisova, 1947: 143, pl. 30, fig. 3, text-fig. 30.

Columbites constrictilis Astakhova, 1960a: 140, pl. 33, fig. 6, text-fig. 8.

This species is remarkably similar to *Pseudoceltites cheneyi* n. sp. from the *Columbites* fauna of southeastern Idaho in its conch shape, ornament, and suture. The differences are primarily centered on the pattern of forward projecting constrictions on the adoral part of the conch. This species cannot be assigned to *Columbites* as the patterns of ribs and constrictions are very different. Astakhova (1960a) distinguished her species *constrictilis* from *Columbites dolnapaensis* Kiparisova partly on the basis that *constrictilis* had two denticulations on the first lateral lobe, and *dolnapaensis* had three. Examination of Figure 25, with 12 sutures of *P. cheneyi*, will give some indication of the variations possible within the basic pattern of the suture.

Occurrence. Mangyshlak Peninsula, *Columbites* Zone of Astakhova (1960a), associated with *Albanites*, *Epiceltites* and *Olenekites*.

Pseudoceltites nevadi n. sp.

Plate 34, figures 1–5; Text-figure 21

Xenoceltites cf. *X. spitsbergensis*.—Silberling, in Hose and Repenning, 1959: 2189, 2194.

The collections contain a large number of fragmentary, poorly preserved specimens. The basic form of the conch, whorl cross-section, pattern of ribs, and suture is very much like that of *Pseudoceltites cheneyi* from the *Columbites* fauna of southeastern Idaho. The suture (Figs. 21 and 25) likewise is very similar. It is possible that these two species are conspecific, but *nevadi* attains a much greater size than *cheneyi*, and on this basis it is thought best to keep the forms separate.

One fragment must be from a specimen of a diameter of approximately 65 mm.

Occurrence. USGS fauna M111, from upper part of Thaynes Formation, in section 15 of Hose and Repenning (1959: 2187), Confusion Range, western Utah.

Repository. Holotype USNM 153078 (Pl. 34, fig. 1); paratypes USNM 153079 (Pl. 34, figs. 2, 3), USNM 153080 (Pl. 34, figs. 4, 5).

Genus *Procolumbites* Astakhova, 1960

Type species, *Procolumbites karataucikus* Astakhova, 1960

Procolumbites karataucikus Astakhova
Text-figure 26

Procolumbites karataucikus Astakhova, 1960a: 142, pl. 34, figs. 1a–c, text-fig. 9 (*nomen nudum* Bajarunas, 1936: 547).

A columbitid with low ventral keel on phragmocone, venter on body chamber rounded. Ornamented with radial ribs and constrictions that cross the venter. Suture (Fig. 26G) with single, pointed, lateral lobe.

Occurrence. This genus and species is only known from the upper Scythian formation of the Mangyshlak Peninsula in beds associated with *Pseudoceltites dolnapaensis*, *Olenekites mangyshlakensis*, and *Albanites triadicus*.

Genus *Prenkites* Arthaber, 1911

Type species, *Prenkites malsorensis* Arthaber, 1911

There are only three species of this genus. One of these (*timorensis*) is known from Chios, Timor, and China. The type species is represented in the *Subcolumbites* fauna of Albania and Chios, whereas the third species (*helenae*) is only known from the Chios fauna.

Prenkites malsorensis Arthaber

Plate 7, figures 7–10; Text-figure 26

Prenkites malsorensis Arthaber, 1911: 258, pl. 22(6), figs. 17–19; Diener, 1915: 226; C. Renz, 1931: 344; Spath, 1934: 208, pl. 12,

figs. 7a–c, text-figs. 111f–h; Renz and Renz, 1947: 59; Renz and Renz, 1948: 29, pl. 12, figs. 11–11a, 12.

Arthaber (1911: 258) stated he had 29 specimens of this species, but of these only 6 are still preserved in the Paleontological Institute, Vienna. In contrast to this fair representation, the *Subcolumbites* fauna of Chios has yielded only two specimens. The general character of the conch and the suture (Fig. 26A, B) is quite similar to that of *P. timorensis* which is distinguished on the basis of its ornamentation. *Prenkites helenae* Renz and Renz (1948) is a more broadly evolute form with rounded umbilical shoulders and lacking the small nodes on the umbilical shoulder.

Occurrence. *Subcolumbites* fauna of Albania and Chios.

Repository. Six specimens, including the two figured by Arthaber (1911: pl. 22(6), figs. 17, 19; Pl. 7, figs. 7–10 of this report) are in the Paleontological Institute, Vienna. The two plesiotypes from Chios, NHMB J13574, J13575.

Prenkites helenae Renz and Renz Text-figure 26

Prenkites helenae Renz and Renz, 1947: 60, 74; Renz and Renz, 1948: 30, pl. 12, figs. 2–2a, 5–5a.

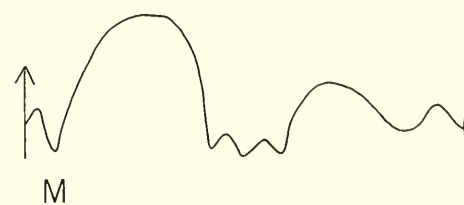
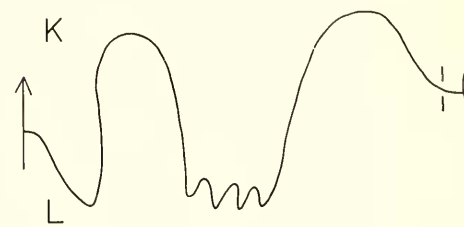
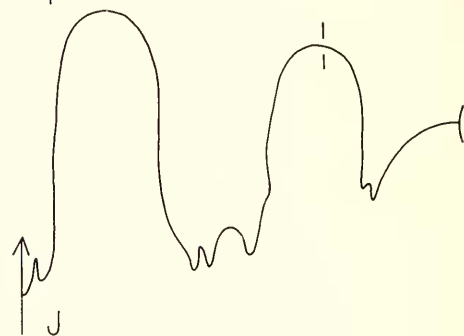
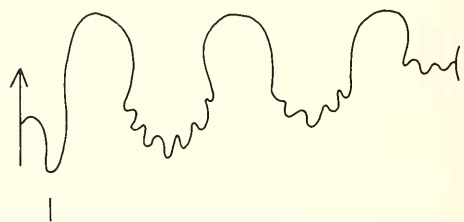
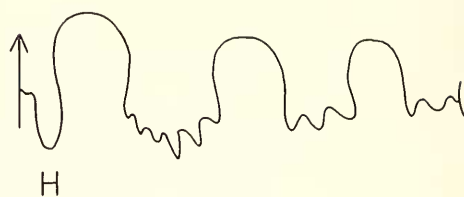
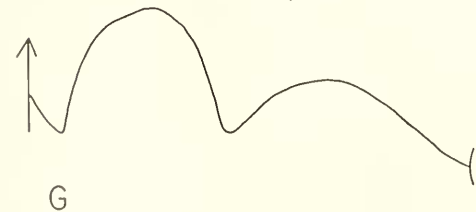
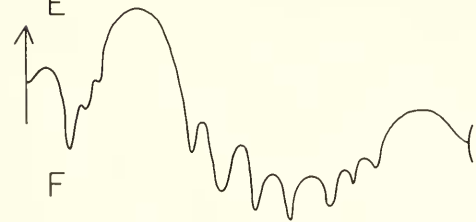
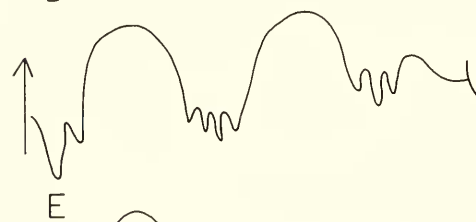
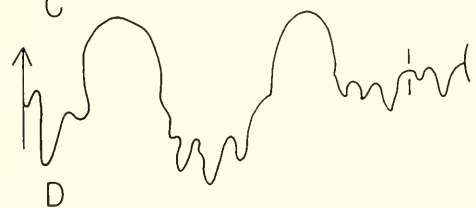
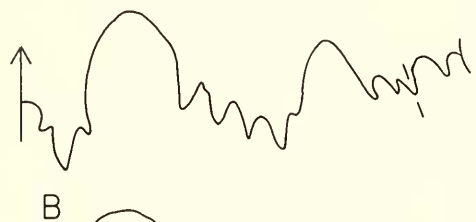
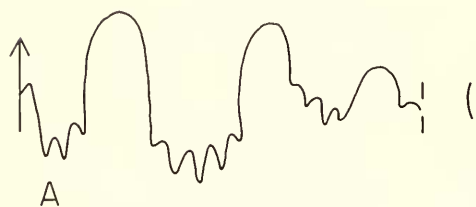
This species is an evolute *malsorensis* with rounded umbilical shoulders that lack the small nodes. The species is based on only two specimens; the measurements of the holotype are Diameter 49.3 mm, Width 18.5 mm, Height 18.3, Umbilicus 17.5, the same for the paratype are Diameter 35.8, Width 17.8, Height 12.1, Umbilicus 14.6. The suture is shown on Figure 26C.

Occurrence. *Subcolumbites* fauna, Chios.

Repository. Holotype NHMB J13577; paratype NHMB J13578; unfigured paratypes from Maradovuno J13579, 13580.

Prenkites timorensis Spath Text-figures 17, 26

Columbites nov. sp. indet. Welter, 1922: 150, pl. 168(14), figs. 12, 13.



Preunkites timorensis Spath, 1930: 77; Spath, 1934: 208, fig. 62d, e.

Columbites malayanus C. Renz, 1945: 301; C. Renz, 1947: 176; Renz and Renz, 1947: 59, 73; Renz and Renz, 1948: 24, pl. 9, figs. 5, 6-6c, 8-8b, 9-9d, 10.

Columbites malayanus var. *crassa* Renz and Renz, 1947: 59, 73; Renz and Renz, 1948: 26, pl. 9, figs. 4-4b.

Columbites bubulinae Renz and Renz, 1947: 59, 73; Renz and Renz, 1948: 26, pl. 9, figs. 7-7a, pl. 10, figs. 1-1b.

Columbites levantinus Renz and Renz, 1947: 59, 74; Renz and Renz, 1948: 27, pl. 10, figs. 2-2b.

Columbites hellenicus Renz and Renz, 1947: 59, 74; Renz and Renz, 1948: 28, pl. 11, figs. 9-9c.

Columbites ex aff. *plicatuli* Smith,—Renz and Renz, 1948: 23.

Preunkites kwangsiensis Chao, 1959: 130, 307, pl. 29, figs. 15-20, text-fig. 42b.

Columbites huangi Chao, 1959: 126, 301, pl. 29, figs. 6-11, text-fig. 41a.

Columbites costatus Chao, 1959: 126, 302, pl. 29, figs. 1-3, text-fig. 41b.

Columbites yaliensis Chao, 1959: 126, 302, pl. 29, figs. 12-14.

This is the "ornamented" species of *Preunkites*. It has a conch essentially like that of *P. malsorensis* except for constrictions and associated ribs which extend over the flanks and project adorally as they cross the venter. Welter (1922) had only one specimen of this species and this is the type; a second specimen is in the British Museum (Natural History). The *Subcolumbites* fauna from Chios has yielded eight specimens which I believe are conspecific with the Timor form originally

TABLE 39. MEASUREMENTS OF *PREUNKITES TIMORENSIS* SPATH.

	D	W	H	U	W/D	H/D	U/D
1.	45.2	22.8	23.0	15.5	50.4	50.9	34.3
2.	45.2	?	17.4	16.0	?	38.5	35.4
3.	42.0±	24.4	15.6	15.7	58.1±	37.1±	47.4±
4.	38.5	22.7	15.3	13.5	59.0	39.7	35.1
5.	36.5	21.7?	14.4	12.3	59.5?	39.5	33.7
6.	34.8?	24.7?	13.0	14.7	71.0?	37.4?	42.2?
7.	32.0	15.1	13.2	10.0	47.2	41.3	31.3
8.	29.1	20.5	12.8	8.2	70.4	44.0	28.2

1. Holotype, *Columbites bubulinae* Renz and Renz (1948: pl. 10, fig. 1), NHMB J13561.
2. Paratype, *Columbites bubulinae* Renz and Renz (1948: pl. 9, fig. 7), NHMB J13562.
3. Paratype, *Columbites malayanus*,—Renz and Renz (1948: pl. 9, fig. 9), J13558.
4. Holotype, *Columbites malayanus*,—Renz and Renz (1948: pl. 9, fig. 6), J13555.
5. Paratype, *Columbites malayanus*,—Renz and Renz (1948: pl. 9, fig. 8), J13557.
6. Type specimen, *Columbites malayanus* var. *crassa* Renz and Renz (1948: pl. 9, fig. 4), J13549.
7. Holotype, *Columbites hellenicus* Renz and Renz (1948: pl. 11, fig. 9), J13573.
8. Paratype, *Columbites malayanus*,—Renz and Renz (1948: pl. 9, fig. 5), J13556.

described by Welter (1922). Their measurements are given on Table 39. Renz and Renz (1948: 24) were not familiar with Spath's publications (1930, 1934) in which he introduced the name *Preunkites timorensis* for *Columbites* sp. indet. Welter (1922: 150, pl. 168(14), figs. 12, 13). *Columbites malayanus* Renz and Renz was introduced for a series of Chios forms that were believed to be conspecific with the Timor *Columbites* sp. indet. of Welter. A second species, *Columbites bubulinae* Renz and

Figure 26. Diagrammatic representation of the suture of: A, *Preunkites malsorensis* Arthaber (1911: pl. 22(6), fig. 17c), at a diameter of 20 mm; B, *Preunkites malsorensis*,—Renz and Renz (1948: pl. 12, fig. 12), at a diameter of approximately 15 mm; C, *Preunkites helenae* Renz and Renz (1948: pl. 12, fig. 5b), at a diameter of approximately 25 mm; D, *Preunkites timorensis*,—Renz and Renz (1948: pl. 9, fig. 9d), at a diameter of approximately 27 mm; E, *Preunkites timorensis*,—Chao (1959: fig. 42b), at a diameter of approximately 20 mm; F, *Protapites hilmi* Arthaber (1911: pl. 22(6), fig. 16), at an unknown diameter; G, *Pracolumbites karataucikus* Astakhova (1960a: fig. 9), at a diameter of approximately 20 mm; H, *Chioceras mitzopouloi* Renz and Renz (1948: pl. 12, fig. 13), at a diameter of approximately 30 mm; I, *Chioceras nadasum* Renz and Renz (1948: pl. 12, fig. 7c), at a diameter of approximately 20 mm; J, *Arianites musacchi* Arthaber, new suture from holotype (Pl. 2, figs. 9, 10), at a diameter of 20 mm; K, *Merapella plejanae* Renz and Renz (1948, pl. 3, fig. 4b); L, *Epiceltites gentii* Arthaber (1911: pl. 24(8), fig. 8d), at a diameter of 20 mm; M, *Epiceltites subgracilis* (Astakhova, 1960a: fig. 132), at a diameter of approximately 15 mm.

Specimens of figures A, F, J, L from *Subcolumbites* fauna of Albania; specimens of figures B, C, D, H, I, K from *Subcolumbites* fauna of Chios; specimen of figure E from *Subcolumbites* fauna of Kwangsi, China; G, M from upper Scythian horizon on the Mangyshlak Peninsula.

Renz was introduced for slightly more compressed forms. A third species, *Columbites hellenicus* Renz and Renz is a slightly aberrant form, compressed, with more rounded umbilical shoulders and with a more subdued pattern of ornamentation. This species is based on a single specimen and is considered here as falling within the pattern of variation of *P. timorensis*.

Columbites ex aff. *plicatuli*, Renz and Renz (1948: 23) is based on two fragmentary specimens that have nothing in common with *Columbites plicatulus* Smith (1914: 37). They are actually more like the forms Renz and Renz assigned to *Columbites bubulinae*.

Prenkites kwangsiensis Chao (1959) was established on three specimens from *Subcolumbites* horizons in Kwangsi, China. The descriptions and illustrations of this species leave much to be desired. In spite of this, I believe this species to be conspecific with the forms from Timor and Chios assigned to *P. timorensis*. The insight one can get on the variation within this species from a study of the Chios fauna lends support to the conclusion that the differences in the ribbing used by Chao to distinguish his species are not of specific importance. The Kwangsi species of *Columbites*—*huangi*, *costatus*, and *yaliensis*—described by Chao (1959) occur together at least in some outcrops and with *Prenkites kwangsiensis* at the Yali section. These three species are clearly conspecific; they differ only in the degree of ribbing. These three forms are remarkably similar to *Columbites levatinus* Renz and Renz (1948: pl. 10, fig. 2) from the *Subcolumbites* fauna of Chios. Analysis of the whole Chios fauna suggests that *Prenkites timorensis* is a highly variable species that can and should include *Columbites levatinus*. These Kwangsi species (*C. huangi*, *costatus*, and *yaliensis*) are here considered to be a variant similar to *C. levatinus* which belongs within the scope of *P. timorensis*.

The suture of *Columbites huangi* Chao

is shown on Figure 17C; *Prenkites timorensis* Spath is illustrated on Figures 26D, E.

Occurrence. *Subcolumbites* fauna of Chios; from block E, Nifoekoko, Timor; from *Subcolumbites* fauna in the Linglo and Fengshan districts of Kwangsi, China (Chao collections 542a, 546, 610); *Prenkites* aff. *timorensis* is present in the *Subcolumbites* fauna of the Primorye Region.

Repository. Holotype, Paleontological Institute, Bonn; topotype BMNH C33714; holotype, *Columbites malayanus* Renz and Renz (1948: pl. 9, fig. 6) NIIMB J13555; paratypes (pl. 9, fig. 9) NHMB J13558, (pl. 9, fig. 8) NHMB J13557, (pl. 9, fig. 5) NHMB J13556; var. *crassa* (pl. 9, fig. 4) NIIMB J13549, (pl. 9, fig. 10) NHMB J13559; unfigured paratypes NHMB J13546; holotype *Columbites bubulinae* Renz and Renz (1948: pl. 10, fig. 1) NIIMB J13561; paratype (pl. 9, fig. 7) NIIMB J13562; unfigured paratypes from Maradovuno NIIMB J13563, from Kephalovuno NIIMB J13569; holotype *Columbites hellenicus* Renz and Renz (1948: pl. 11, fig. 9) NIIMB J13573.

Genus *Protropites* Arthaber, 1911

Type species, *Protropites hilmi* Arthaber, 1911 (lectotype selected by Spath, 1934)

Involute, inflated forms with cadicone inner whorls and carinate outer whorls. With strongly prosiradiate growth lines, occasionally enlarged on crossing the keel. Suture with single wide lateral lobe.

The type species is the only one known for this genus and has been recognized only in the *Subcolumbites* fauna of Kçira, Albania. Spath (1934: 206) considered *Protropites* to be an extreme development of *Subcolumbites mirditensis*. In this conclusion I concur. The rather poor preservation of the available material does not permit analysis of the ontogeny of the only known species; however, in its gross morphological features and the suture it does appear to be a columbitid though its exact relationships remain uncertain.

Protropites hilmi Arthaber

Plate 14, figures 1–8; Text-figure 26

Protropites hilmi Arthaber, 1911: 256, pl. 22(6), figs. 9–16; Diener, 1915: 235; Renz, 1928: 155; Spath, 1934: 206, pl. 13, figs. 4a–c.

Arthaber's illustrations of the *Subcolumbites* fauna of Albania are retouched photographs which on the whole are successful. Arthaber illustrated six specimens plus a suture (Fig. 26F) from an unspecified specimen. Two of these specimens plus the specimen which yielded the suture are missing in the collection and presumed lost. These are the specimens of figures 10, 11, and 16 of plate 22(6) in Arthaber (1911). The collections of the Paleontological Institute at the University of Vienna contain approximately 20 specimens of the species with no label as to origin, collector, etc. It is presumed that these are part of the original collection from Këira, studied by Arthaber. Unfortunately, the preservation of these specimens is uniformly bad, none yielded any sutures, and none could yield any useful measurements.

None of the four surviving primary types studied by Arthaber are particularly well preserved. The measurements of these specimens are as follows:

	D	W	H	U	W/D	H/D	U/D
1.	33.2	?	12.1	12.6	?	36.4	38.0
2.	32.2	10.5?	11.9	12.8	32.6?	37.0	39.8
3.	29.2	10.2	11.4	10.8	34.9	39.0	37.0
4.	25.5	11.2	10.5	10.6	43.9	41.2	41.6

1. Lectotype, Arthaber (1911: pl. 22(6), fig. 15a, b).
2. Paralectotype, Arthaber (1911: pl. 22(6), fig. 13a, b).
3. Paralectotype, Arthaber (1911: pl. 22(6), fig. 12a, b).
4. Paralectotype, Arthaber (1911: pl. 22(6), fig. 14a, b).

The lectotype (Pl. 14, figs. 3, 4) was selected by Spath (1934: 206). Only the venter and one side of the specimen are preserved. The keel is very well developed and present on the whole adoral volution. Because of poor preservation, surface features of the shell are obscure. Faint

patches of growth lines are present and on the most adoral part of the last volution there are two broad radial folds. The umbilical shoulder of the inner volutions appears to bear small nodes, but these are obscured by the poor preservation.

The largest of Arthaber's figured paralectotypes (Pl. 14, figs. 1, 2) is a more compressed form with less inflated whorls. Likewise only one side and the venter of the specimen is preserved. The next paralectotype (Pl. 14, figs. 5, 6) is of the same preservation and is an even more compressed form. The inner whorls are not as depressed and cadicone as in the lectotype. The growth lines are in places well preserved and show the strong forward projection on the keel. Some of the growth lines on crossing the keel are enlarged. The specimen figured by Spath (1934: pl. 8, fig. 4a) is comparable to this compressed form. The fourth specimen (Pl. 14, figs. 7, 8) is the most inflated, with strongly depressed cadicone inner whorls. It shows the gradual contraction of the body chamber very well. The conch is smooth except for very faint and indistinct growth lines.

Occurrence. *Subcolumbites* fauna, Këira, Albania.

Repository. Lectotype, three figured paralectotypes, and approximately 20 topotype specimens are in the Paleontological Institute, University of Vienna. There are eight topotype specimens in the British Museum (Natural History) (C22838–45).

Genus *Chioceras* Renz and Renz, 1947

Type species, *Chioceras mitzopouloi* Renz and Renz, 1947

Smooth, evolute conchs, inner whorls rounded, slightly depressed, showing progressive expansion; outer whorls with conspicuous, smooth rounded keel; body chamber slightly more than one volution in length; suture with two denticulated lateral lobes, third lobe on umbilical shoulder, saddles rounded. One species bears large lateral nodes.

This genus is known only from two

species from the *Subcolumbites* fauna of Chios. It is, however, fairly well represented in numbers of individuals in the Chios fauna, as preserved in the Natural History Museum in Basel.

The rounded keel immediately reminds one of *Protopites* and at first these forms were thought to belong to that genus. However, the cadicone inner whorls of *Protopites* and the completely different suture preclude any genetic relationship. It is interesting to note that whereas *Protopites hilui* is fairly well represented in the *Subcolumbites* fauna of Albania, it is not present in the fauna from Chios.

The character of the suture appears to be the best indication of genetic relations and this suggests *Prosphingites*. The conch can be looked upon as an evolute form of *Prosphingites* with the marked addition of the rounded keel.

Chioceras mitzopouloi Renz and Renz

Text-figure 26

Chioceras mitzopouloi Renz and Renz, 1947: 60, 74; Renz and Renz 1948: 37, pl. 12, figs. 3-3b, 6-6a (holotype), 9-9a, 13; Kummel, in Arkell et al., 1957: L140, figs. 172, 10a-c.

Chioceras mitzopouloi var. *meridionalis* Renz and Renz, 1947: 10; Renz and Renz, 1948: 38, pl. 12, figs. 8-8b.

This is the smooth species of *Chioceras*. The measurements of the holotype and figured paratypes are as follows:

	D	W	H	U	W/D	H/D	U/D
1.	49.0	?	16.6	19.7	?	33.9	40.2
2.	44.3	14.8	15.9	16.7	33.4	35.9	37.7
3.	43.5	13.7	13.1	18.4	31.5	30.1	42.3
4.	33.9	13.8	10.5	15.5	40.7	31.0	45.7
5.	30.6	10.8	10.7	13.0	35.3	35.0	42.5

1. Holotype, Renz and Renz (1948: pl. 12, fig. 6) NHMB J13626.
2. Paratype, Renz and Renz (1948: pl. 12, fig. 13) NHMB J13627.
3. var. *meridionalis* Renz and Renz (1948: pl. 12, fig. 8) NHMB J13632.
4. Paratype, Renz and Renz (1948: pl. 12, fig. 9) NHMB J13628.
5. Paratype, Renz and Renz (1948: pl. 12, fig. 3) NHMB J13629.

There are numerous unfigured paratypes

in the Chios collection in Basel that are too poorly preserved or prepared to yield useful measurements. The suture is shown on Figure 26H.

Occurrence. *Subcolumbites* fauna, Maradovuno, Kephlovuno, and Marmarotrap-eza, Chios.

Repository. The figured specimens are listed in the table of measurements; in addition there are unfigured paratypes from Maradovuno NHMB J13630, and from Kephlovuno NHMB J13631.

Chioceras nodosum Renz and Renz

Text-figure 26

Chioceras nodosum Renz and Renz, 1947: 60, 74; Renz and Renz, 1948: 38, pl. 12, figs. 7-7c.

This species was established for a single species that is like *C. mitzopouloi* except for the presence of large, rounded nodes on the lateral areas. The measurements of the holotype are:

D	W	H	U	W/D	H/D	U/D
30.5	12.1	10.7	12.5	39.7	35.1	41.0

The suture is illustrated on Figure 26I.

Occurrence. *Subcolumbites* fauna, Maradovuno, Chios.

Repository. Holotype NHMB J13633; unfigured paratype NHMB J13634.

Genus *Arianites* Arthaber, 1911

Type species, *Arianites musacchi* Arthaber, 1911

This genus and species are based on a single poorly preserved specimen from the *Subcolumbites* fauna of Albania. I agree with Spath (1934: 209) that it is most probably a columbitid.

Arianites musacchi Arthaber

Plate 2, figures 9, 10; Text-figure 26

Arianites musacchi Arthaber, 1911: 264, pl. 24(8), fig. 5; Diener, 1915: 53; Spath, 1934: 209; Kummel, in Arkell et al., 1957: L140, fig. 172, 14.

The type, and only specimen, of this species is incomplete and generally poorly preserved. The last half volution is body

chamber; the inner whorls are for the most part buried in matrix. The outer volution is completely smooth except for vague traces of growth lines. A small portion of the penultimate volution is visible, and this shows sharp radial ribs on the flanks and umbilical shoulder. A new drawing of the suture is reproduced here on Figure 26J. Arthaber's drawing of the suture is inaccurate, especially in his treatment of the first lateral lobe.

Occurrence. *Subcolumbites* fauna, Këira, Albania.

Repository. Paleontological Institute, Vienna.

Genus *Meropella* Renz and Renz, 1947

Type species, *Arianites* (*Meropella*) *plejanæ* Renz and Renz, 1947

Evolute conchs with rounded whorl section of approximately equal width and height dimensions. Ventral and umbilical shoulders rounded. Early volutions bear slight umbilical nodes.

The suture consists of two bifid lateral lobes and a smooth, small auxiliary lobe on the umbilical shoulder.

This genus and species is known only from the *Subcolumbites* fauna of Chios. A fragmentary specimen from the *Subcolumbites* fauna of Kotal-e-Tera, Afghanistan, has been described by Kummel (1968b) as *Meropella* cf. *plejanæ*.

Meropella plejanæ Renz and Renz

Plate 20, figures 14, 15; Text-figure 26

Arianites (*Meropella*) *plejanæ* Renz and Renz, 1947: 67, 79; Renz and Renz, 1948: 95, pl. 3, figs. 3-3b, 11-11b.

Meropella plejanæ.—Kummel, in Arkell et al., 1957: L140, fig. 172, 12.

There are only four specimens of this species known. The measurements of these are:

	D	W	H	U	W/D	H/D	U/D
1.	22.5	5.7	5.8	11.8	25.3	25.8	52.4
2.	20.0	4.6	5.7	9.8	23.0	28.5	49.0
3.	14.6	4.0	4.0	7.3	27.5	27.5	50.0
4.	12.5	3.2	3.6	5.6	25.6	28.8	44.8

1. Figured paratype, Renz and Renz (1948: pl. 3, fig. 11) NHMB J13826.
2. Holotype, Renz and Renz (1948: pl. 3, fig. 4) NHMB J13825.
- 3, 4. Unfigured paratypes, NHMB J13827.

One of the unfigured paratypes of the Renz and Renz monograph is figured here on Plate 20, figures 14, 15. Neither of these small paratype specimens shows the umbilical nodes as present in the holotype, nor is the suture preserved. However, aside from the lack of nodes, the remaining features of the conch are identical to those of the holotype. The drawing of the suture (Renz and Renz, 1948: pl. 3, fig. 4b) is accurate and is reproduced here as Figure 26K.

Occurrence. *Subcolumbites* fauna, Maradovuno, Chios.

Repository. Holotype NHMB J13825; figured paratypes NHMB J13826 (Renz and Renz, 1948: pl. 3, fig. 11), NHMB J19550 (Pl. 20, figs. 14, 15); unfigured paratypes NHMB J13827.

Genus *Epiceltites* Arthaber, 1911

Type species, *Epiceltites gentii* Arthaber, 1911

Epiceltites gentii Arthaber

Plate 3, figures 10, 11; Plate 35, figures 6, 7; Text-figure 26

Epiceltites gentii Arthaber, 1911: 268, pl. 24(8), fig. 8; Diener, 1915: 131; C. Renz, 1928: 155; Kutassy, 1933: 510; Spath, 1934: 210, pl. 13, figs. 5a-d; Renz and Renz, 1947: 60; Renz and Renz, 1948: 43, pl. 1, figs. 9a-d.

Epiceltites n. sp. cf. *E. gentii*.—Kummel, 1954: 187.

Arthaber (1911) had five specimens of this unique species of which only the holotype (Pl. 3, figs. 10, 11) is still preserved in the Paleontological Institute, Vienna. The evolute, compressed conch with periodic flares or constrictions that are strongly projected forward on the venter makes identification of this species easier than with most species of Scythian ammonoids. The holotype measures 36.3 mm in diameter, 9.3 mm for the width of the last whorl, 12.8 mm for the height of the last

whorl, and 14 mm for the diameter of the umbilicus.

The *Subcolumbites* fauna of Chios also contains this species. The specimen figured by Renz and Renz (1948: pl. 1, fig. 9) measures 31 mm in diameter, 7.3 mm for the width of the last whorl, 10.3 mm for the height of the last whorl and 12.6 mm for the diameter of the umbilicus.

The Thaynes Formation of southeastern Idaho has yielded two incomplete and poorly preserved specimens. One specimen (Pl. 35, fig. 6) consists of only a portion of one side of the conch, thoroughly embedded in matrix; the other specimen (Pl. 35, fig. 7) shows only the venter and part of the lateral area of one-half volution. As no suture is preserved on either of the specimens, there has been some hesitation as to their specific identity. However, with due consideration of the preservation and incompleteness of the specimens, I feel that the shape and involution of the conch and the pattern of ornamentation are so similar to the specimens of this species from Albania and Chios that one must assign these specimens to Arthaber's species. Arthaber's suture is reproduced on Figure 26L.

Occurrence. The holotype is from the *Subcolumbites* fauna of Albania. The species is also known from that same fauna from Chios, and from the uppermost member of the Thaynes Formation, Hammond Creek, Bear River Range, southeastern Idaho.

Repository. Holotype, Paleontological Institute, Vienna; topotypes BMNH C-22867-74. Specimens from Chios, NHMB J13657 (Renz and Renz, 1948: pl. 1, fig. 9); unfigured specimens NHMB J13658, J13659. Specimens from southeastern Idaho MCZ 9470 (Pl. 35, fig. 6), MCZ 9471 (Pl. 35, fig. 7).

Epiceltites subgracilis (Astakhova)

Text-figure 26

Anasibirites subgracilis Astakhova, 1960a: 147, pl. 34, fig. 8, text-fig. 13.

The general shape etc. of the conch and the suture (Fig. 26M) is very much like that of the type species. The pattern of ornamentations is sufficiently different to warrant separation.

Occurrence. From *Columbites* Zone of Astakhova (1960a), Mangyshlak Peninsula.

Family USSURIIDAE Spath, 1930

Genus *Parussuria* Spath, 1934

Type species, *Ussuria compressa* Hyatt and Smith, 1905

Parussuria latilobata Chao

Parussuria latilobata Chao, 1959: 94, p. 260, pl. 31, figs. 14, 15, text-fig. 31.

The few species that previously have been assigned to this genus are of mid-Scythian age; this is the first species from a late Scythian horizon, and it is known from only a single specimen. Chao (1959: 261) concluded that his species was most closely related to *Parussuria ivanovi* (Diener, 1895) from the Primorye Region. In this I am in complete agreement; in fact, these two specimens could well be conspecific. Unfortunately, precise data on the stratigraphic position of *P. ivanovi* are lacking. This species was not in the faunas described by Kiparisova (1961) from the Primorye Region.

Occurrence. Limestone block in Lolou village, Kwangsi, China (Chao collection 542b).

Family HEDENSTROEMIIDAE Waagen, 1895

Genus *Metahedenstroemia* Spath, 1934

Type species, *Hedenstroemia kastrotae* Arthaber, 1911

This is a very unsatisfactorily defined genus because the type specimen is most probably an immature form of only modest preservation. Spath (1934) considered the suture to be the most unique aspect of his new genus. The suture as illustrated by Arthaber (1911) is highly idealized. As with practically all the specimens from the *Subcolumbites* fauna of Albania and Chios,

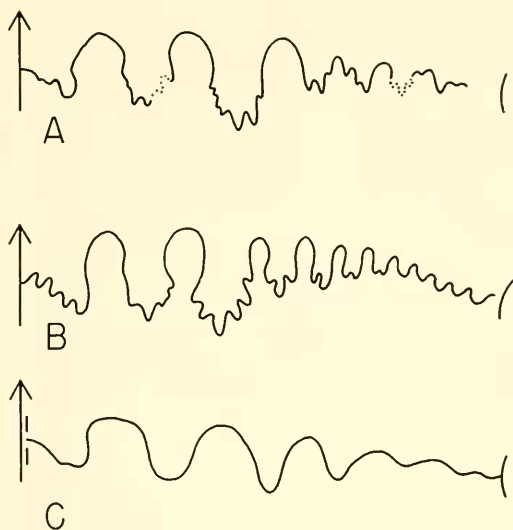


Figure 27. Diagrammatic representation of the suture of: A, holotype of *Metahedenstroemia kastriotae* (Arthaber), from the *Subcolumbites* fauna of Albania, at a diameter of 36 mm; B, holotype *Hedenstroemia pityoussae* Renz and Renz (1948: pl. 16, fig. 8b), from the *Subcolumbites* fauna of Chios, at a diameter of approximately 20 mm; C, holotype *Beatites berthae* Arthaber (1911), from *Subcolumbites* fauna of Albania, new drawing at a diameter of 32 mm.

the suture can be exposed only by grinding. In the case of the type specimen of this genus the grinding has been excessive. A new drawing of the suture, as exposed, is shown on Figure 27A. The Chios species, *Hedenstroemia pityoussae* Renz and Renz (1948), differs from the type species of *Metahedenstroemia* in details of the suture. However, as I believe the differences are due mainly to the results of specimen preparation and are more apparent than real, I consider the two species conspecific. This genus and species is known only from the *Subcolumbites* fauna of Albania and Chios.

***Metahedenstroemia kastriotae* (Arthaber)**
Plate 14, figures 9, 10; Text-figure 27

Hedenstroemia kastriotae Arthaber, 1911: 208, p. 17(1), figs. 14a-c; Diener, 1915: 148.

Metahedenstroemia kastriotae.—Spath, 1934: 223, fig. 72; Kummel, in Arkell et al., 1957: L140, fig. 173, 10.

Hedenstroemia pityoussae Renz and Renz, 1947: 61, 78; Renz and Renz, 1948: 83, pl. 16, figs. 8-8b.

Arthaber (1911: 208) had two specimens of this species but only the specimen Spath (1934: 223) selected as the type of his genus *Metahedenstroemia* is still preserved in the Paleontological Institute, University of Vienna. This specimen is all phragmocone and measures 36.4 mm in diameter, 22.0 mm for the height of the last whorl, and 4.7 mm for the width of the last whorl. It is illustrated here on Plate 14, figures 9, 10 and the suture on Figures 27A, B.

The species *Hedenstroemia pityoussae* described by Renz and Renz (1948: 83) from the *Subcolumbites* fauna of Chios is based on three small fragmentary specimens. These authors differentiated their species on the basis of the suture; these differences are, however, partly due to preservation and preparation of the specimen.

Occurrence. *Subcolumbites* fauna of Albania and Chios.

Repository. Holotype is in the Paleontological Institute, Vienna; specimens from Chios, holotype, NHMB J13791; unfigured paratypes NHMB J13792.

Genus *Beatites* Arthaber, 1911

Type species, *Beatites berthae* Arthaber, 1911

Highly compressed, involute form with oxynote venter; sinuous growth lines. Suture long with low goniatitic lobes and saddles.

***Beatites berthae* Arthaber**

Plate 21, figures 3, 4; Text-figure 27

Beatites berthae Arthaber, 1911: 210, pl. 17(1), fig. 15; Diener, 1915: 66; Diener, 1917: 169; Welter, 1922: 98; Kummel, in Arkell et al., 1957: L142, fig. 173, 4.

The dimensions of the holotype (and only specimen of this genus and species) are: Diameter 32.3 mm, Width 3.7 mm,

Height 16.0 mm, Umbilicus 5.8 mm. The specimen is essentially all phragmocone. The flanks of the penultimate half volution have the wrinkle layer well preserved. The suture has been exposed by grinding; whether this has affected the details of the lobes is not known. Arthaber's suture drawing is not as accurate as it should be and a new drawing is reproduced here on Figure 27C.

Occurrence. *Subcolumbites* fauna, Këira, Albania.

Repository. Paleontological Institute, University of Vienna.

Genus *Lanceolites* Hyatt and Smith, 1905
Type species, *Lanceolites compactus* Hyatt and Smith, 1905

Until recently this genus has been known only from the *Meekoceras* limestone of Idaho, Nevada, and California. In addition to the type species, Smith (1932: 90) has described one other (*L. bicarinatus*) which is clearly closely related to the type species and may be conspecific with it. Neither of these species are very common in the *Meekoceras* limestone of western United States. Recently Ganey (1966) has described *L. discoidalis* on four specimens from the Campil Member of the Werfen Formation of eastern Bulgaria. As these forms are associated with a typical Werfen tirolitid fauna, they are considered to be of *Prohungarites* Zone age. This new record considerably extends the range of the genus.

***Lanceolites discoidalis* Ganey**

Lanceolites discoidalis Ganey, 1966: 23, pl. 1, figs. 1, 2, 4.

The conch shape of this species is nearly identical to that of the species from the *Meekoceras* limestone of western United States. In this respect the Bulgarian species is more similar to *L. bicarinatus* than to *L. compactus*, which appears to have a slightly more inflated conch. However, so few specimens of any of these species

are known that there are no data available on the amount of variability possible in conch inflation. The suture of *L. discoidalis* has the same basic pattern as that of the American species but details are quite different. Through the kindness of Dr. Ganey I have plastotypes of his specimens. I suspect, from studying these, that the lack of fine denticulations in the suture is the result of poor preservation and weathering. At the same time, the suture is not too unlike that of *L. bicarinatus* reproduced by Smith (1932: pl. 55, figs. 3, 5, 7, 10), or that of weathered specimens of *L. compactus* reproduced by Smith (1932: pl. 5, fig. 9).

Occurrence. Campil Member, Werfen Formation, perhaps as exotic blocks, Luda-Kamčija region of eastern Bulgaria.

Repository. Primary types in Geological Institute of the Bulgarian Academy of Science; plaster casts are in the MCZ.

Family MEEKOCERATIDAE Waagen, 1895

Genus *Svalbardiceras* Frebold, 1930

Type species, *Lecanites* (?) *spitzbergensis* Frebold, 1929

***Svalbardiceras spitzbergensis* (Frebold)**

Plate 26, figures 1–4; Text-figure 28

Lecanites (?) *spitzbergensis* Frebold, 1929b: 299, pl. 1, fig. 1; Kutassy, 1933: 577.

Ammonites sp. indet. Frebold, 1929a: 14, pl. 1, fig. 12.

Ammonites sp. indet. Frebold, 1929a: 15, pl. 1, fig. 13.

Svalbardiceras spitzbergensis (Frebold), 1930: 24, pl. 6, figs. 1–3; Spath, 1934: 251, fig. 85; Kummel, in Arkell et al., 1957: L142.

Interpretation of this species has been in doubt amongst several authors, mainly due to the uncertainty as to the nature of the suture. The holotype is the specimen described by Frebold in 1929 (1929b: pl. 1, fig. 1) and not that figured by Frebold in 1930 (pl. 6, fig. 1–1a), as indicated by Spath (1934: 251). The holotype specimens came from Agardhberge on Storfjord, Spitsbergen. The specimens described by Frebold (1929a) as *Ammonites*

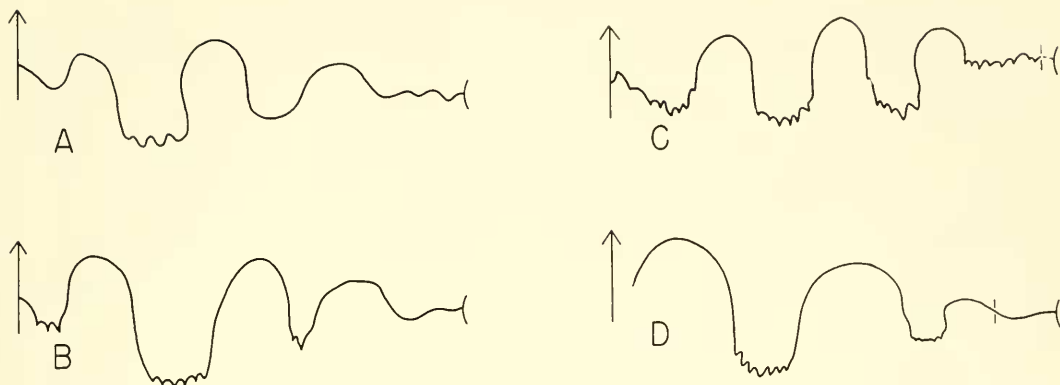


Figure 28. Diagrammatic representation of the sutures of several species of *Svalbardiceras*. A, topotype of *Svalbardiceras schmidtii* (Mojsisovics), from Olenekites Zone, Olenek region, Siberia, at a whorl height of 13 mm (Popov, 1961: 39, fig. 6b); B, *Svalbardiceras* sp. indet., from Upper Thaynes Formation, Hammond Creek, southeastern Idaho, at a whorl height of 15 mm (MCZ 9488); C, holotype of *Svalbardiceras sheldoni* n. sp., from Columbites fauna, Thaynes Formation, Draney Creek, southeastern Idaho, at a diameter of 38 mm (MCZ 9493); D, *Svalbardiceras spitzbergensis* (Frebold, 1929a: pl. 1, fig. 13; Pl. 26, figs. 3, 4 of this report), from upper Scythian beds, Cape Thordsen, Spitsbergen, at a diameter of 37 mm.

sp. indet., which I believe to be conspecific with the holotype, came from Cape Thordsen. The specimens described in 1930 by Frebold came from Agardh Bay, Milne Edwardsberg, and Botneheia (Corrie Down). All these specimens came from what is interpreted as a late Scythian horizon. The specimens from Cape Thordsen were associated with a *Keyserlingites*.

All of the known specimens of this species show it to be an evolute form with compressed whorls, higher than wide, and with a flattened venter. The inner whorls bear slight radial ribs which are strongest near the umbilical shoulder and decrease down the flank; the weak ribs can be observed throughout the phragmocone. On the living chamber, the pattern of ornamentation is more irregular and is more like irregular bundled growth lines. The full details of the suture were not available to Frebold, but on one of his specimens—*Ammonites* sp. indet. (Frebold, 1929a: pl. 1, fig. 13; Pl. 26, figs. 3, 4 of this report)—it has been possible to develop the suture (Fig. 28D). The suture bears two lateral lobes that are clearly denticulated, and a smooth auxiliary lobe on the umbilical wall. The highly crystalline nature of the

phragmocone on many of the Spitsbergen ammonites makes development of the suture generally very difficult.

This Spitsbergen species of *Svalbardiceras* is quite similar to the other species of the genus but tends to be more involute and with more development of an ornamental pattern than the Siberian *S. schmidtii*. The Idaho *S. sheldoni* has very different whorl dimensions and a more elaborate suture.

Occurrence. From presumably the uppermost Scythian horizon at Agardh Bay, Milne Edwardsberg, Botneheia (Corrie Down), and Cape Thordsen, Spitsbergen.

Repository. The holotype was in the Mineralogisch-Geologischen Staatsinstitut, Hamburg, but was destroyed in the great fire of 1943; the specimens described by Frebold (1929a) are in the Paleontologisk Museum, Oslo; the specimens described by Frebold (1930) are in the Geologisk Institut, Uppsala.

***Svalbardiceras schmidtii* (Mojsisovics)**
Plate 26, figure 5; Text-figure 28

Xenodiscus schmidtii Mojsisovics, 1886: 77, pl. 11, figs. 8–11.

Gyronites mojsisovicsi Waagen, 1895: 297 (=

Xenodiscus schmidtii Mojsisovics, 1886: pl. 11, figs. 11a-c); Spath, 1934: 90, 251.
Prionolobus schmidtii,—Noetling, in Frech, 1905: pl. 28, figs. 6a, b.
Meekoceras (*Gyronites*) *schmidtii*,—Diener, 1915: 197.
Meekoceras sp. indet. Frebold, 1929a: 13, pl. 1, fig. 11.
Svalbardiceras spitzbergensis (Frebold) 1930: 24, pl. 6, fig. 2.
Gyronites (?) *schmidtii*,—Kiparisova, 1947: 134, pl. 30, figs. 4, 5, text-fig. 16.
Svalbardiceras schmidtii,—Tozer, 1961a: 32.
Nordophiceras schmidtii,—Popov, 1961: 39, pl. 12, fig. 3.

Popov (1961: 39) recognized that his Siberian species was very similar to *Svalbardiceras spitzbergensis* (Frebold) but on the argument that the suture of this latter species was "unsatisfactorily defined" and that the suture was unknown he felt a comparison was not possible. It is true that no drawing of a suture was presented with the original description of *Lecanites* (?) *spitzbergensis* Frebold (1929b: 299, pl. 1, fig. 1), but they are visible on the photograph of the specimen. Frebold, however, interpreted the lobes as being goniatitic. The two specimens Frebold (1929a: 14, 15, pl. 1, figs 12, 13) described as *Ammonites* sp. indet. were considered by their author as most probably closely related to *Lecanites* (?) *spitzbergensis*; I believe them to be conspecific to that species. One of these specimens does preserve the suture (Fig. 28D) and this clearly shows denticulated lobes; the general pattern of the suture is identical to that shown on the photograph of the holotype (Frebold, 1929b: pl. 1(36), fig. 1). It does not, on this basis, seem justified to disregard *Svalbardiceras* as a valid generic name.

Acceptance of *Svalbardiceras* can and does clarify the genus *Nordophiceras* Popov (1961) from the Olenek region, Siberia. Within this new genus, Popov (1961) included a variety of species described by Mojsisovics (1886) as *Xenodiscus schmidtii*, *Xenodiscus dentosus*, *Xenodiscus enomphalus* and the holotype,

Xenodiscus karpinskii; in addition, Popov (1961) described one new species, *Nordophiceras alexeevae*. Thus within his genus *Nordophiceras*, Popov (1961) combined what I consider to be a heterogeneous assemblage of species. The group includes round ventered forms as illustrated by *Xenodiscus karpinskii*, the holotype of *Nordophiceras*, and forms with truncate venters as illustrated by *Xenodiscus schmidtii* and *X. dentosus*. It is this latter group which is more properly allied to the Spitsbergen species of *Svalbardiceras*.

Mojsisovics (1886) illustrated three specimens of his *Xenodiscus schmidtii*; the principal variation observable is in the sharpness of the ventral shoulders. Waagen (1895: 297) renamed the form shown on Mojsisovics' plate 11, figure 11a, b, as *Gyronites mojsisovicsi*. This additional name did not add clarity to the understanding of the group. Spath (1934: 251) lists the specimen of Mojsisovics (1886: pl. 11, fig. 8a, b) as lectotype.

Of the species of *Nordophiceras* described by Popov (1961), his specimen of *Nordophiceras schmidtii* (Fig. 28A) is like that of Mojsisovics (1886: pl. 11, fig 9) in which the venter is slightly rounded but the ventral shoulders still quite distinct. I would, however, also include in this species *Meekoceras* sp. indet. Frebold (1929a: pl. 1, fig. 11; Pl. 26, fig. 5 of this report). This specimen has the very flat venter with angular ventral shoulders shown by Mojsisovics' specimen of *schmidtii* on his plate 11, figure 11. Likewise the abrupt umbilical shoulder and the nature of the growth lines are nearly identical. The suture is unfortunately not preserved. In addition, the specimen of *Svalbardiceras spitzbergensis* (Frebold, 1930: pl. 6, fig. 2) should be included. Both of these specimens differ from the other Spitsbergen specimens assigned to *S. spitzbergensis* in being more involute and having a higher height-width relationship in the whorl dimensions. This is the primary difference between *S. schmidtii* and *S. spitzbergensis*. The general

conch form of *S. sheldoni* is like that of *S. schmidt*, but in this species there are conspicuous transverse ribs on the venter and differences in the spacing of the suture elements.

Occurrence. Mojsisovics' species are only listed as coming from the region of the mouth of the Olenek River. Popov (1961) lists his specimens as from his *Olenekites* Zone. Frebold's specimen of *Meekoceras* sp. indet. is from Cape Thordsen, associated with *Keyserlingites*; his specimen of *Svalbardiceras spitzbergensis* (Frebold, 1930: pl. 6, fig. 2) is from Milne Edward Mountain.

Repository. The only specimen of this species personally handled is Frebold's *Meekoceras* sp. indet., and this is in the Paleontological Museum, Oslo, Norway.

Svalbardiceras sibiricum (Mojsisovics)

Meekoceras sibiricum Mojsisovics, 1886: 85, pl. 11, figs. 1–6; Spath, 1934: 224, 246, 254, 274, 341.

Aspidites sibiricus.—Frech, 1905: pl. 28, fig. 11. *Meekoceras* (*Koninckites*) *sibiricum*.—Diener, 1915: 198.

Meekoceras ? *sibiricum*.—Kiparisova, 1947: 150, pl. 35, fig. 2.

Hemiprionites sibiricus.—Popov, 1962a: 176, 187, pl. 2, fig. 3.

This species has been a puzzle to most students of Triassic ammonoids. Tozer (1965a: 37) suggested assignment of this species to *Svalbardiceras* and I believe there is much merit in this suggestion. The umbilical width of slightly less than 10 percent the diameter of the conch makes this the most involute species of the genus. As already pointed out by Tozer (1965a: 37), Popov's (1962a) assignment of this species to *Hemiprionites* cannot stand for many reasons.

Occurrence. Olenek fauna, mouth of Olenek River, northern Siberia.

Svalbardiceras dentosus (Mojsisovics)

Xenodiscus dentosus Mojsisovics, 1886: 78, pl. 11, figs. 12a, b.

Goniodiscus dentosus.—Diener, 1915: 135; Spath, 1934: 330.

This species is like *S. schmidt* except for long, low clavi along the sharp ventral shoulders. It is based on a single specimen.

Occurrence. From near the mouth of the Olenek River.

Svalbardiceras freboldi Tozer

Svalbardiceras freboldi Tozer, 1965a: 36, pl. 4, figs. 12, 13, pl. 5, fig. 2, text-fig. 11.

With an umbilical width approximately 20 percent the diameter of the conch, this is one of the more involute species of *Svalbardiceras*. Aside from the slightly greater involution, it is very similar to *schmidt* and *spitzbergensis*.

Occurrence. Uppermost Scythian, Blaa Mountain Formation, lower shale member, northern Ellesmere Island.

Svalbardiceras chowadei Tozer

Svalbardiceras chowadei Tozer, 1965a: 37, pl. 4, figs. 9–11.

This species could very well be conspecific with *S. spitzbergensis*. The differences are mainly in a slight difference in the degree of involution. However, with both species the number of specimens known is so small that really no data are available on the range of variability of any of the morphological features.

Occurrence. Toad Formation, Halfway River area, British Columbia.

Svalbardiceras sheldoni n. sp.

Plate 43, figure 1; Text-figure 28

The *Columbites* fauna of southeastern Idaho has yielded three specimens which form the basis for this new species. The two larger specimens are embedded in matrix with only one side completely exposed and a portion of the venter on the phragmocone, and the body chamber exposed. The body chamber is crushed. The holotype specimen measures 70 mm in diameter; the height of the adoral volution is 30 mm and the umbilicus has a diameter of 22.7 mm. The conch is evolute, compressed, and essentially smooth. The

venter is flat, and aligned by angular ventral shoulders. The lateral areas are broadly convex with the maximum breadth at about mid-way between the ventral and umbilical shoulders. The umbilical shoulders are likewise sharply rounded and the umbilical wall is vertical. The body chamber occupies approximately two-thirds of a volution. The shell bears fine growth lines that are slightly prosiradiate. On the phragmocone the venter has narrow, shallow, transverse grooves that extend from one ventral shoulder to the other.

The suture is shown on Figure 28C. It consists of a wide ventral lobe, highly denticulated, two lateral lobes, and a serrated shallow lobe adjacent to the umbilical shoulder. The large paratype has an inner core of 59 mm in diameter of excellent preservation. Attached to it is a portion of body chamber with a whorl height of 39 mm. The specimen must have had a diameter of at least 100 mm. The small paratype has a diameter of 25.2 mm, and the whorl shape of the large specimens. At a diameter of 4 mm the venter is rounded; it appears that in the following volutions the venter begins to become flattened.

This species has a remarkable similarity to *Svalbardiceras schmidtii* (Mojsovics, 1886: 77, pl. 11, figs. 11a, b), that is, in the identity of the greatly compressed, evolute conch, and the flattened venter. *Svalbardiceras schmidtii* appears to have a smooth venter, lacking transverse furrows. The essential plan of the suture is the same except that the ventral lobe lies within the venter and does not spread out on the lateral areas as in *S. sheldoni*. Mojsovics noted a fair degree of variability in the nature of the venter of his species, some forms having rounded venters and ventral shoulders. This observation has been confirmed by Popov (1961).

The Spitsbergen species, *S. spitzbergen-sis* (Frebold, 1930: 24, pl. 6, figs. 1-3) tends to be slightly more inflated than the species described here. Likewise, the

lateral area bears weak radial ribs, widely spaced on the inner whorls, but becoming more bunched and sinuous on the body chamber. The venter bears weak transverse furrows.

Occurrence. From middle shale member of Thaynes Formation (*Columbites* fauna), on hillside north of Sage Creek, Stewart Flat Quadrangle, and at Hot Springs, southeast Idaho.

Repository. Holotype MCZ 9493; paratypes MCZ 9643, 9644.

Svalbardiceras sp. indet. (S.E. Idaho)

Text-figure 28

Svalbardiceras sp. Kummel, 1954: 187.

This specimen is recognized on the basis of a fragment of phragmocone consisting of only five camerae. The whorl height is 14 mm, and the width is 7.3 mm. The cross section of the whorl is compressed, the lateral areas broadly convex. The venter is slightly concave, measuring about 2 mm in breadth, and lined by angular ventral shoulders. The umbilical shoulder is broadly rounded. The suture is shown on Figure 28B. The specimen recorded here is much too fragmentary to compare in a detailed fashion with the Spitsbergen and Olenek species, but in its whorl shape and suture it agrees well with the basic conch pattern for the genus.

Occurrence. Upper member Thaynes Formation, Hammond Creek, Bear River Range, southeast Idaho.

Repository. MCZ 9488.

Svalbardiceras sp. indet. (Pakistan)

Svalbardiceras sp. indet., Kummel, 1966: 394, pl. 2, figs. 6-9.

This identification was based on a complete phragmocone and a fragment of another. The specimens are complete enough to confidently assign them to the genus *Svalbardiceras* but are not sufficiently complete to make any meaningful comparisons with other species of the genus.

Occurrence. Narmia Member of Mian-

wali Formation, Nammal Gorge, Salt Range, West Pakistan.

Repository. MCZ 9587, 9588.

Genus *Stacheites* Kittl, 1903

Type species, *Stacheites prionoides* Kittl, 1903

Compressed, involute forms with tabulate, often sulcate venter. Suture with prominent first lateral lobe and shallow, broad, second lateral lobe; first lateral saddle narrow, second lateral saddle broadly rounded.

The type specimens came from the Werfen Formation in Dalmatia. The type species, *S. prionoides*, is also stated to occur in the Mangyshlak Peninsula in the Caspian region, but unfortunately no specimens from there have been described or illustrated (Astakhova, 1960b). A second species, *S. floweri*, from the *Subcolumbites* fauna of the Tobin Formation of Nevada is described here. An indeterminate species is known from the Narmia Member of the Mianwali Formation in the Salt Range of West Pakistan (Kummel, 1966); likewise, two specifically indeterminate forms are recorded from the Thaynes Formation of southeastern Idaho.

Stacheites dionysi (Renz and Renz, 1948: 50) is here considered to be a synonym of *Metadagnoceras terbunicum* (Arthaber). I agree with Spath (1934: 267) that *Stacheites webbianus* Diener (1907) from the Himalayan Anisian is a completely unrelated stock to the Scythian species discussed here.

Stacheites prionoides Kittl

Plate 56, figures 9, 10; Text-figure 29

Stacheites prionoides Kittl, 1903: 27, pl. 4, fig. 8; Diener, 1915: 266; Spath, 1934: 267, fig. 92.

Kittl's original figure was a highly reconstructed drawing with no view of the venter. The type specimen is illustrated here for the first time. It can be seen that the specimen is a compressed form but obviously crushed. The opposite side of the conch is completely missing. The

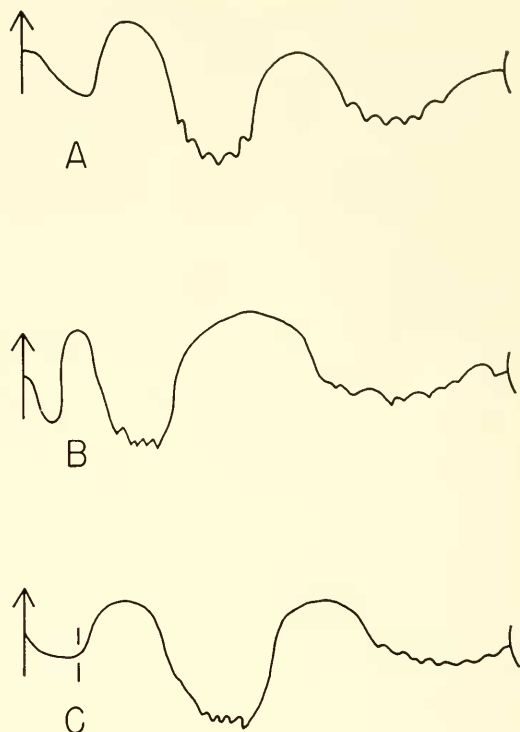


Figure 29. Diagrammatic representation of the suture of: A, *Stacheites prionoides* Kittl (1903: pl. 4, fig. 8), at a diameter of 33 mm, from Werfen Formation, Dalmatia; B, *S. floweri* n. sp., composite suture from specimens MCZ 9439 and 9491, at a diameter of approximately 35 mm, from *Subcolumbites* fauna, Tobin Formation, Nevada; C, *S. sp. indet. II*, at a diameter of 21 mm, from uppermost Thaynes Formation, Sublette Ridge, western Wyoming (MCZ 9501).

venter is narrow, flattened and sulcate, bordered by acute ventral shoulders. The measurements of Kittl's type are as follows:

D	W	H	U	W/D	H/D	U/D
45.8	?	24.2	5.0	?	52.8	10.9

The suture is slightly weathered and the ventral lobe could well be denticulated, but is too weathered to preserve such features. I consider Kittl's illustrations a fairly good representation of this specimen.

Stacheites prionoides is morphologically quite similar to the only other species of the genus, *S. floweri*, from the Tobin Formation of Nevada. The sutures especially are similar (Fig. 29). The shape

TABLE 40. MEASUREMENTS OF *STACHEITES FLOWERI* N. SP. FROM TOBIN FORMATION, NEVADA.

	D	W	H	U	W/D	H/D	U/D
1.	48.5	?	25.7	5.2?	?	52.9	10.6?
2.	40.5	?	20.8	5.5	?	50.2	13.2
3.	39.7	10.5	22.0	3.9	26.45	54.0	9.9
4.	31.7	8.2?	17.1	3.0	25.9?	53.9	9.48
5.	28.5	8.2?	16.7	2.6	28.75?	58.6	9.1

1. Paratype, MCZ 9440 (Pl. 28, fig. 2).
2. Paratype, MCZ 9444 (Pl. 28, fig. 8).
3. Holotype, MCZ 9441 (Pl. 28, figs. 3, 4).
4. Paratype, MCZ 9445 (Pl. 28, fig. 9).
5. Paratype, MCZ 9443 (Pl. 28, figs. 6, 7).

of the conch, degree of inflation and involution are also strikingly similar. The Nevada species, however, does bear faint sigmoidal ribs on the flanks whereas *S. prionoides*, as far as can be told, is smooth. Astakhova (1960b) records this species from the Mangyshlak Peninsula; in fact she used this as the name species of her highest local zone. Unfortunately, no descriptions or illustrations of these Mangyshlak specimens are available.

Occurrence. Werfen Formation, Mué, Dalmatia.

Repository. The holotype and only specimen of this species is in the Natural History Museum, Vienna.

Stacheites floweri n. sp.

Plate 28, figures 1–10; Text-figure 29

This is the second species of the genus *Stacheites* to be recorded. The species is represented by a fairly large number of specimens, mainly fragmentary. The measurements of five of the most complete specimens are given on Table 40.

The conch is very involute and discoidal. The venter is narrow, typically slightly concave, and bordered by a fairly sharp ridge. In some forms (e.g. Pl. 28, figs. 6, 7) the venter loses its concavity, and the adjoining ventral shoulders are rounded and not angular; on the earlier volutions, however, the former condition prevails. The material available does not allow an evaluation as to the nature and extent of variations in the character of the venter.

The flanks are slightly arched, with the maximum width in the dorsal third of the flank. The umbilical shoulders are abruptly rounded, and the umbilical wall vertical. The flanks bear interesting low falciform ribs. These commence above the umbilical shoulders as very low, narrow, radial ribs. At about the mid part of the flanks, the ribs broaden greatly, and inscribe a concave arc. Where the venter is concave, it is perfectly smooth; on the specimen (Pl. 28, figs. 6, 7) where the venter is not concave, there are faint ridges crossing the venter. In some specimens the falciform ribs are extremely faint.

The suture consists of a fairly broad first lateral lobe, a second lateral saddle occupying about one-third of the width of the flank, and a second lateral lobe that is low, and with a characteristic pattern of denticulation (Fig. 29B).

The basic features of the conch and suture place this species morphologically very close to *S. prionoides*. The falciform ribs are the most obvious distinguishing features.

Occurrence. Tobin Formation, Pershing County, Nevada; south tip of Tobin Range, Cain Mountain 1:62,500 quad., center NW ¼ sec. 9, T. 26N, R. 39E, 5,500 ft. S, 27.5 ft. W from elevation point 5088 on range crest.

Repository. Holotype, MCZ 9441 (Pl. 28, figs. 3, 4); paratypes MCZ 9442 (Pl. 28, fig. 5), MCZ 9443 (Pl. 28, figs. 6, 7), MCZ 9444 (Pl. 28, fig. 8), MCZ 9445 (Pl. 28, fig. 9), MCZ 9446 (Pl. 28, fig. 10), MCZ 9439 (Pl. 28, fig. 1), MCZ 9440 (Pl. 28, fig. 2); suture specimen MCZ 9491; unfigured paratypes MCZ 9500.

Stacheites sp. indet. (S.E. Idaho)

Plate 37, figs. 7–10; Text-figure 29

Two specimens from the Thaynes Formation of southeastern Idaho can be assigned to *Stacheites*. The first of these specimens (Pl. 37, figs. 7, 8) is a weathered individual of only a quarter volution. The narrow concave venter, angular ventral

shoulder, slender compressed conch and distinctive suture are characteristic of the genus. The specimen is too incomplete to allow a specific determination or comparison.

The second specimen (Pl. 37, figs. 9, 10) is a small weathered individual of 33.6 mm in diameter that could well be conspecific with *Stacheites floweri* of the Tobin Formation of Nevada. The venter is flat with angular ventral shoulders. The lateral areas are broadly convex and smooth. The adoral half of the specimen is body chamber. The suture is shown on Figure 29C. The suture is quite similar to that of *S. floweri* except in the ventral lobe, but the differences here could well be the result of weathering.

Occurrence. The first specimen (Pl. 37, figs. 7, 8) came from the Upper Thaynes Formation, Hammond Creek, Bear River Range, southeast Idaho. The second specimen (Pl. 37, figs. 9, 10) came from a float 150–200 feet from top of upper calcareous siltstone member of Thaynes Formation (Kummel, 1954), Spring Canyon, Sublette Ridge, western Wyoming.

Repository. MCZ 9487 (Pl. 37, figs. 7, 8), MCZ 9501 (Pl. 37, figs. 9, 10).

Stacheites sp. indet. (West Pakistan)

Stacheites sp. indet., Kummel, 1966: 396, pl. 3, fig. 13.

This record is based on a single, poorly preserved specimen. The basic conch outline and pattern of suture generically identify the specimen.

Occurrence. The single specimen came from a five-foot limestone bed 38 feet above the base of the Narmia Member of the Mianwali Formation, Narmia Nala, Surghar Range, West Pakistan.

Repository. MCZ 9609.

Genus *Dagnoceras* Arthaber, 1911

Type species, *Dagnoceras nopcsanum* Arthaber, 1911

When Arthaber established this genus

he included within it a varied group of species which are as follows:

Dagnoceras nopcsanum Arthaber
Dagnoceras zappanense Arthaber
Dagnoceras terbunicum Arthaber
Dagnoceras komanum Arthaber
Dagnoceras lejanum Arthaber

As Arthaber (1911) did not select a type species, Diener (1915: 115) selected *D. nopcsanum*. This selection was apparently overlooked by Smith (1932: 65) who selected *D. komanum* as type on the principle that this was the first mentioned species; this is, of course, an invalid selection.

Interpretation of the genus then rests first on a consideration of *D. nopcsanum*. The principal features are a moderately involute conch, with rounded flanks, a rounded umbilicus, and a suture with a large first lateral lobe and small second lateral lobe on or near the umbilical shoulder. Arthaber's (1911) sutures of this group were not accurately reproduced, and new drawings of his type specimens are offered here (Fig. 30). The sutures of all these specimens are to a greater or lesser extent altered by excessive grinding and polishing. *Dagnoceras nopcsanum* and *D. zappanense* are congeneric and actually quite similar. These two species differ mainly in the width of the first lateral lobe. *Dagnoceras lejanum* is a synonym of *D. zappanense*. *Dagnoceras komanum* is completely different in the aspect of the conch morphology and suture and is considered here to be a representative of *Albanites triadicus*. The specimen Arthaber (1911: 254, pl. 22(6), fig. 8) assigned to *Pseudosibirites* cf. *dichotomus* Waagen is also considered to be *Albanites triadicus*. Finally, there is *D. terbunicum*, a species with a narrow truncate venter and with a more elaborate suture. This species is assigned to *Metadagnoceras*. This genus is characterized by elaborate denticulation of the first lateral saddle and first lateral lobe. The conch is not too unlike that of a species

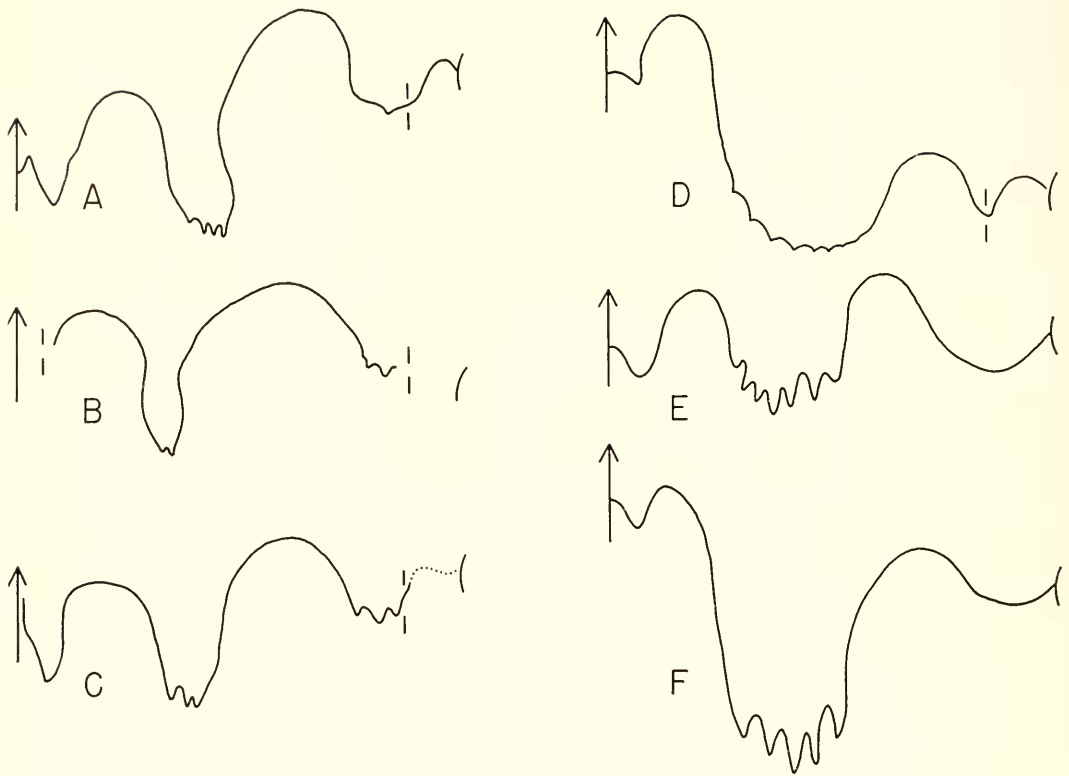


Figure 30. Diagrammatic representation of the sutures of species of *Dagnoceras*. A, syntype of *D. zappanense* Arthaber (1911: pl. 21(5), fig. 8; Pl. 15, figs. 3, 4 of this report), original drawing at a whorl height of 8 mm; B, syntype of *D. zappanense* Arthaber (1911: pl. 21(5), fig. 9; Pl. 15, figs. 5, 6 of this report), original drawing at a whorl height of 11.5 mm; C, syntype of *D. lejanum* Arthaber (1911: pl. 21(5), fig. 13; Pl. 15, figs. 7, 8 of this report), original drawing at a whorl height of 11 mm; D, holotype of *D. nopcsanum* Arthaber (1911: pl. 21(5), fig. 6; Pl. 15, figs. 1, 2 of this report), original drawing at a whorl height of 9 mm; E, *D. ellipticum* Chao (1959: fig. 47a), at a whorl height of 10 mm; F, *D. latilobatum* Chao (1959: fig. 47b), at a whorl height of 8 mm.

Specimens of figures A–D from *Subcolumbites* fauna of Albania; specimen of figure E from isolated block containing typical upper Scythian fauna in Kwangsi, China; specimen of figure F from a *Subcolumbites* fauna in Fengshan District of Kwangsi, China.

of *Dagnoceras*, but some species do have truncate venters, at least during a part of their ontogeny. *Metadagnoceras* appears to be a valid genus, distinct from *Dagnoceras*. However, it needs to be emphasized that the sutures of the two type specimens of *D. nopcsanum* are affected by grinding and polishing, and one cannot be sure as to how much these factors have given the suture its apparent simple pattern. None of the specimens of *D. nopcsanum* in the British Museum (Natural History) show the suture.

In addition to Albania, *Dagnoceras* is known from a single specimen (*D. zappanense*) from the *Prohungerites* fauna of Timor. The genus is known also from two species from late Scythian faunas in Kwangsi, China. A fragmentary specimen assigned to *D. cf. zappanense* has been recorded from the Narmia Member of the Mianwali Formation in the Surghar Range of West Pakistan (Kummel, 1966). It is of interest to note that no species of this genus has been recorded from the *Subcolumbites* fauna of Chios. *Dagnoceras*

(?) *unicum* Kiparisova from the Primorye Region is here assigned to *Metadagnoceras*. The three species from the *Meekoceras* fauna of southeastern Idaho that Smith (1932) assigned to *Dagnoceras* (*D. bonnevillense*, *D. bridgesi*, and *D. haydeni*) are completely unlike the type species and are excluded from this genus.

***Dagnoceras nopcsanum* Arthaber**

Plate 15, figures 1, 2; Plate 16, figures 1, 2; Text-figure 30

Dagnoceras nopcsanum Arthaber, 1911: 241, pl. 21(5), figs. 6, 7; Diener, 1915: 115; Spath, 1934: 268–271, pl. 8, fig. 1, text-fig. 93a; Kummel, in Arkell, et al., 1957: L144, fig. 175, 1.

The two specimens of this species that Arthaber figured are the only specimens remaining in the original collection. They have the following measurements:

	D	W	H	U	W/D	H/D	U/D
Holotype	28.5	9.1	11.1	10.0	49.2	38.9	35.1
Paratype	36.3?	?	16.2	11.2	?	44.6?	30.9?

(Arthaber, 1911: pl. 21(5), fig. 6)

(Arthaber, 1911: pl. 21(5), fig. 7)

The holotype is a specimen of only fair preservation. The conch is evolute with a broad and fairly deep umbilicus. The whorls are oval in cross-section with a narrowly rounded venter, broadly convex lateral areas, an acutely rounded umbilical shoulder, and a steep umbilical wall. The greatest width of the whorls is at the umbilical shoulder. The specimen is essentially all phragmocone and devoid of any ornamentation or growth lines. The suture is shown on Figure 30D. As with all the specimens from the *Subcolumbites* fauna of Albania, the suture is revealed only by grinding and polishing, and in this case it is not possible to evaluate the full extent of the damage. The paratype has been so badly ground and polished that the suture is essentially meaningless. The holotype was prepared in slightly less damaging fashion but there is grave uncertainty as to whether the first lateral

saddle and the first lateral lobe are as simple as shown on Figure 30D. The character of this part of the suture is critical for determining the relations of this species to those species assigned to *Metadagnoceras*.

Of the five species established by Arthaber from the Albanian Kçira fauna, only the type, *D. nopcsanum*, and *D. zappanense* are accepted as valid members of *Dagnoceras*. *Dagnoceras nopcsanum* differs from *D. zappanense* mainly in the suture, especially in the character of the first lateral lobe (Fig. 30B, D).

Occurrence. *Subcolumbites* fauna, Kçira, Albania.

Repository. Arthaber's two figured specimens are in the Paleontological Institute, University of Vienna.

***Dagnoceras zappanense* Arthaber**

Plate 15, figures 3–11; Plate 24, figures 4, 5; Text-figure 30

Dagnoceras zappanense Arthaber, 1911: 241, pl. 21(5), figs. 8, 9; Diener, 1915: 115; Spath, 1934: 268–271, pl. 7, fig. 2, text-fig. 93d, e, f. *Dagnoceras* cf. *zappanense*,—Kummel, 1966: 396, pl. 3, figs. 9, 10.

Dagnoceras lejanum Arthaber, 1911: 242, pl. 21(5), figs. 12, 13; Diener, 1915: 115; Spath, 1934: 269 (footnote), 271, text-fig. 93c.

The four specimens of this species figured by Arthaber are available for study. This species differs from *D. nopcsanum* mainly in the very slender first lateral lobe (Figs. 30A, B). In addition, there is some ornamentation. One specimen (Pl. 15, fig. 11) has faint umbilical nodes, and another faint sigmoidal ribs (Pl. 15, fig. 6). The other two specimens are smooth, which may be due to preservation or excessive preparation.

Arthaber distinguished between *D. zappanense* and *D. lejanum* on the basis of degree of involution and ornamentation. Both these characters are known to be highly variable in most ammonite species, and though the sample available is much too small to see "gradations," it is felt

that we are dealing here with a single species complex.

The measurements of the four illustrated types are as follows:

	D	W	H	U	W/D	H/D	U/D
1.	42.7	12.1	17.5	13.3	28.3	40.9	31.1
2.	37.2	12.3	18.4	9.1	33.1	49.5	24.5
3.	33.1	11.5	16.2	7.2	34.7	48.9	21.8
4.	30.1	10.7	13.7	8.5	35.5	45.5	28.2

1. Lectotype, *D. lejanum* Arthaber (1911: pl. 21(5), fig. 13).
2. Lectotype, *D. zappanense* Arthaber (1911: pl. 21(5), fig. 9).
3. Paralectotype, *D. zappanense* Arthaber (1911: pl. 21(5), fig. 8).
4. Paralectotype, *D. lejanum* Arthaber (1911: pl. 21(5), fig. 12).

The sutures of these two species are likewise nearly identical (Figs. 30A, C). Arthaber's drawings of the sutures for these species are deceptive; his drawing of the suture of *D. zappanense* (Fig. 30B) actually terminates on the umbilical shoulder, while that for *D. lejanum* (Fig. 30C) terminates on the umbilical seam.

The specimen from Timor identified by Spath (1934: 271, 272) as inseparable from *D. lejanum* is figured here on Plate 24, figures 4, 5. I completely agree with Spath on this conclusion; the specimen, though smaller, is nearly identical to the smaller paralectotype of *D. lejanum* illustrated here on Plate 15, figures 9–11. A fragmentary specimen of a form quite similar to this species has been recorded by Kummel (1966) from the Narmia Member of the Mianwali Formation, Surghar Range, West Pakistan, in association with *Procamites kokeni*.

Occurrence. *Subcolumbites* fauna, Kçira, Albania, *Albanites* fauna, Nifockoko, Timor; Narmia Member of Mianwali Formation, Surghar Range, West Pakistan.

Repository. The four types of Arthaber's are in the Paleontological Institute, University of Vienna; the specimen from Timor is BMNH C33713; the specimen from West Pakistan is MCZ 9565.

Dagnoceras latilobatum Chao

Text-figure 30

Dagnoceras latilobatum Chao, 1959: 142, 322, pl. 18, figs. 6–8.

This species was founded on two specimens with a "narrow, subtruncate venter" and "obtusely rounded" ventral shoulders. The suture (Fig. 30F) is characterized by a very large first lateral lobe. On the basis of the data available, I believe it to be a valid species of this genus.

Occurrence. From black, thick-bedded limestone about 1.5 km north of Yali, Kwangsi, China, associated with *Subcolumbites*, *Hellenites*, etc. (Chao collection 546).

Dagnoceras ellipticum Chao

Text-figure 30

Dagnoceras ellipticum Chao, 1959: 143, 323, pl. 18, figs. 3–5, text-fig. 47a.

This species is based on a single specimen which, however, is poorly illustrated. From the data available, it is clearly a species of *Dagnoceras* of the general type of *nopcsanum*, the type species. It differs from *nopcsanum* in its suture (Fig. 30E) but not enough data are available to analyze the relationships.

Occurrence. Upper limestone bed, Naliling section near village of Lolou, Linglo District, Kwangsi, China, associated with *Hellenites*, *Prenkites*, etc. (Chao collection 542a).

Genus *Metadagnoceras* Tozer, 1965

Type species, *Metadagnoceras pulcher* Tozer, 1965

This genus is characterized by its large, highly denticulated first lateral lobe and narrow first lateral saddle, that may or may not be denticulated. This basic plan of the suture is like that of *Dagnoceras* except for the pattern of denticulation. The suture of *Dagnoceras nopcsanum* is known only from the type specimen, and this suture has been affected by grinding. Taking this into consideration, the dif-

ferences between *Dagnoceras* and *Metadagnoceras* in regards to the suture are not all that great.

The genus *Metadagnoceras* includes the following species:

- M. pulcher* Tozer
- M. tobini* n. sp.
- M. unicum* (Kiparisova)
- M. freemani* Kummel
- M. terbunicum* (Arthaber)

Metadagnoceras pulcher occurs in the Toad Formation of British Columbia closely associated with species of *Isculitoides* and *Keyserlingites*; *Metadagnoceras tobini* is from the Tobin Formation of Nevada, associated with *Subcolumbites* etc.; *Metadagnoceras unicum* is from the Primorye Region, presumably from a late Scythian horizon (*Columbites* Zone); *Metadagnoceras freemani* is from the *Prohungarites* fauna of Timor; and *Metadagnoceras terbunicum* is from the *Subcolumbites* fauna of Albania and Chios.

This newly recognized genus is as yet incompletely known; three of the species (*unicum*, *freemani*, and *pulcher*) are known from only one specimen, and the other two species by a few specimens of only modest preservation.

Metadagnoceras pulcher Tozer

Text-figure 31

Metadagnoceras pulcher Tozer, 1965a: 29, pl. 1, figs. 11a-e.

This unique species was based on a single, well preserved specimen. It is readily differentiated by its suture (Fig. 31A) and its delicate strigate sculpture.

Occurrence. Toad Formation, Halfway River area, British Columbia.

Metadagnoceras tobini n. sp.

Plate 27, figures 1-4; Text-figure 31

This species is based on four fragmentary specimens of fair preservation. The conch is moderately involute with compressed whorls. The lateral areas are

broadly arched, the venter low but rounded and bordered by rounded but distinct ventral shoulders. The umbilical shoulder is more abruptly rounded and the umbilical wall is nearly vertical. The flanks bear sinuous growth lines and the living chamber of one of the larger specimens has faint indications of widely separated low radial undulations. The venter on the two largest specimens is unfortunately not preserved; it is assumed that in these mature specimens the venter is like that of the smaller specimen illustrated on Plate 27, figures 1, 2.

The suture (Fig. 31B) consists of a large first lateral lobe which has denticulations extending up the ventral side to a narrow and irregular first lateral saddle. There is a second lateral lobe on the umbilical shoulder and wall. The second lateral saddle is asymmetric and rounded.

In its conch shape and dimensions, *Metadagnoceras tobini* is distinct from all the other species of this genus. However, its suture is nearly identical to the suture of *M. freemani* (Fig. 31D).

Occurrence. Lower part of Tobin Formation, USGS Locality M2562, Pershing County, Nevada; south tip of Tobin Range, Cain Mountain 1:62,500 quad., center NW $\frac{1}{4}$ sec. 9, T. 26N, R. 39E, 5,500 ft. S, 27.5 ft. W of elevation point 5088 on range crest.

Repository. Holotype (Pl. 27, fig. 3) MCZ 9637; paratypes (Pl. 27, figs. 1, 2) MCZ 9638, (Pl. 27, fig. 4) MCZ 9639; unfigured paratype MCZ 9640.

Metadagnoceras unicum

Text-figure 31

Dagnoceras (?) *unicum* Kiparisova, 1961: 74, pl. 13, fig. 6, text-fig. 35.

This species was based on a single well preserved specimen. In its general conch morphology it differs from other species of the genus in the great width of the whorl in the area of the umbilical shoulder, in the strongly converging whorl sides and

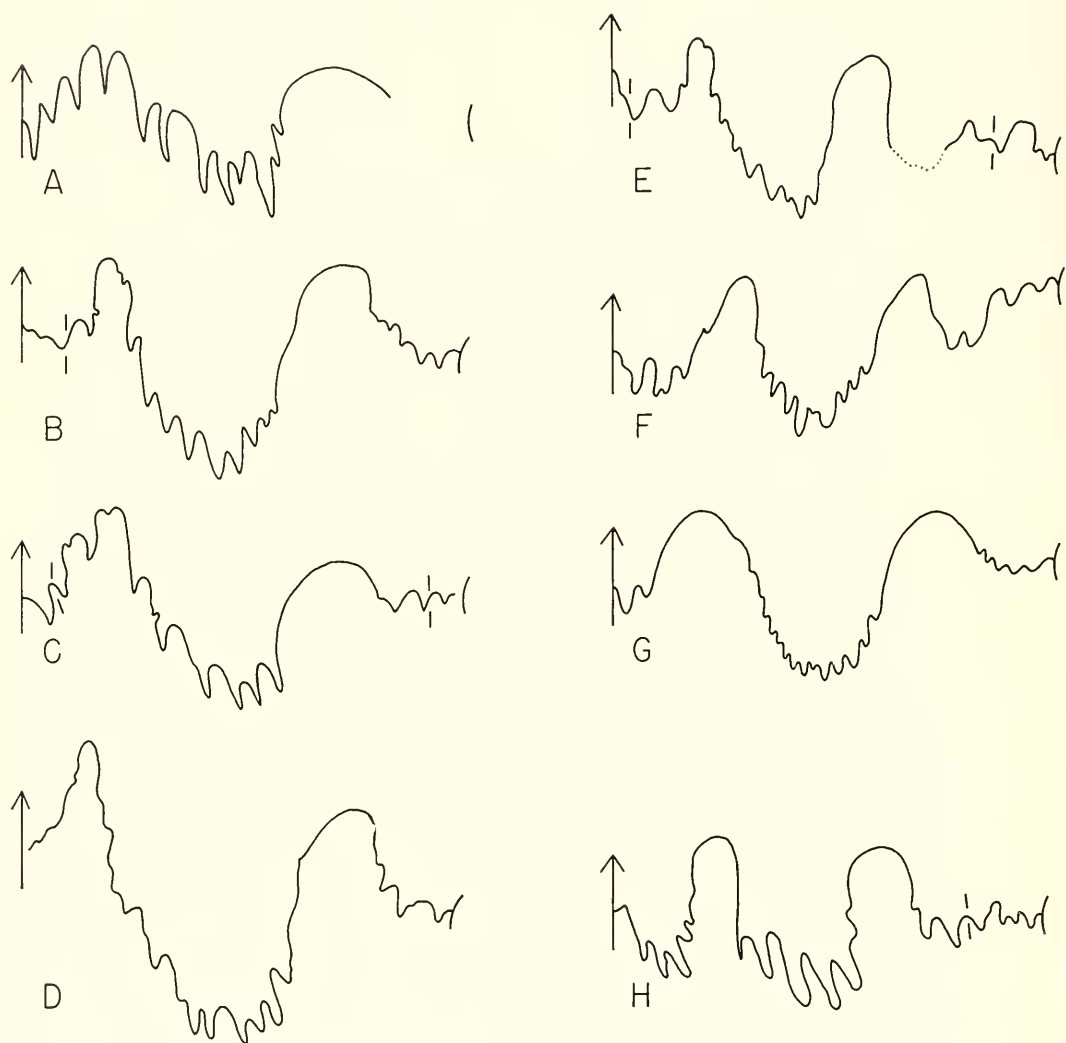


Figure 31. Diagrammatic representation of the sutures of species of *Metadagnoceras*. A, holotype of *M. pulcher* Tozer (1965a: fig. 9), from British Columbia, at a whorl height of approximately 20 mm; B, paratype of *M. tabini* n. sp., from Tobin Formation, Nevada, at a whorl height of 11 mm (MCZ 9638); C, *M. sp.*, undescribed species collected by N. J. Silberling from Star Peak Formation, Nevada, at a whorl height of 22 mm; D, holotype *M. freemani* Kummel, from Nifoekoko, Timor, at a whorl height of 14 mm (BMNH C33701); E, holotype of *M. terbunicum* (Arthaber), from *Subcolumbites* fauna, Albania, at a whorl height of 18 mm; F, plesiotype *M. terbunicum*,—Renz and Renz (1948: pl. 1, fig. 7b), from *Subcolumbites* fauna of Chios at a whorl height of 14 mm (NHMB J13692); G, holotype of *Stacheites dionysi* Renz and Renz (1948: pl. 1, fig. 6b), from *Subcolumbites* fauna of Chios, at a whorl height of 17 mm (NHMB J13689); H, *M. unicum* (Kiperisova, 1961: fig. 35), from late Scythian horizon, Primorye Region, Siberia, at a whorl height of 19 mm.

the narrowly rounded venter. Its suture (Fig. 31H) is likewise quite different.

Occurrence. Russki Ostrov, Cape Schmidt, Primorye Region, from concre-

tions in a dark siltstone together with *Columbites parisianus*. This horizon is probably equivalent to the *Columbites* Zone of southeast Idaho.

Metadagnoceras freemani Kummel

Plate 24, figures 1, 2; Text-figure 31

Metadagnoceras freemani Kummel, 1968a: 11, pl. 1, figs. 12, 13.

This species is proposed for the specimen from Timor mentioned by Spath (1934: 269, footnote) as "an isolated example of a new species from Timor . . . which is very close to *Dagnoceras terbunicum*." The specimen measures 47.8 mm in diameter, 14.7 mm for the width of the last whorl, 21.7 mm for the height of the last whorl, and 10.4 mm for the diameter of the umbilicus. The conch is compressed with a low, arched venter and rounded ventral and umbilical shoulders. The suture (Fig. 31D) has a very large first lateral lobe with denticulations extending all along the ventral side to a narrow irregular first lateral saddle. There is a small denticulated second lateral lobe on the umbilical shoulder and wall.

This species does not resemble *Dagnoceras terbunicum* in conch shape; the differences are centered mainly in the character of the venter. In the suture the first lateral saddle and the first lateral lobe of the two species are quite similar (Figs. 31D–F) but the remainder of the suture is quite different. In general conch morphology *Metadagnoceras freemani* is quite similar to the type species, *M. pulcher* Tozer. The sutures are similar in basic plan but differ in significant details. The suture of *M. tobini* n. sp. is very nearly identical to that of *M. freemani*, but in the Nevada species the whorls are of quite different proportions and the conch much more evolute.

Occurrence. Nifoekoko, Timor, from bed with manganese coated fossils, including *Albanites*, *Prohungarites*, etc.

Repository. BMNH C33701, holotype.

Metadagnoceras terbunicum (Arthaber)

Plate 16, figures 7, 8; Plate 18, figures 9, 10; Text-figure 31

Dagnoceras terbunicum Arthaber, 1911: 242, pl. 21(5), figs. 10a–c; Diener, 1915: 115; Spath,

1934: 269; Renz and Renz, 1947: 60; Renz and Renz, 1948: 51, pl. 1, figs. 7–7b.

Meckoceras radiosum,—Arthaber (non Waagen) 1911: 246, pl. 21(5), fig. 14; Diener, 1915: 194.*Dagnoceras* aff. *terbunicum*,—C. Renz, 1928: 155.*Dagnoceras nopessanum* Arthaber var. *involuta* Renz and Renz, 1947: 60; Renz and Renz, 1948: 52, pl. 1, figs. 5–5a.*Stacheites dionysi* Renz and Renz, 1947: 60, 75; Renz and Renz, 1948: 50, pl. 1, figs. 6–6b, 8–8b.

When Arthaber proposed his genus *Dagnoceras*, he included within it a heterogeneous group of species. One of these was *D. terbunicum*, characterized by a flat venter and angular ventral shoulders, which is in striking contrast to the rounded venter of the more typical species. Arthaber (1911: 240) recognized the similarity of his new generic group to *Stacheites* but was uncertain of the character of the venter of Kittl's *S. prionoides*. My own examination of *S. prionoides* clearly establishes that Kittl's type specimen has a slightly sulcate venter with angular ventral shoulders. The basic morphological features of the conch of *Dagnoceras terbunicum* do suggest, at first, the possibility of this species being a more inflated representative of *Stacheites*. The basic plan of the suture, however, is more like that found in *Metadagnoceras* than that found in *Stacheites*. Arthaber's (1911: pl. 21(5), fig. 10c) representation of the suture is misleading. A new drawing of the suture from this type specimen is shown here on Figure 31E. There is a large first lateral lobe, with prominent denticulations on the base of the lobe and extending up on the ventral side of the lobe to a narrow, irregular first lateral saddle. There is a small second lateral lobe above the umbilical shoulder that apparently has a few denticulations which are, however, indistinct because of excessive grinding; this is followed over the umbilical shoulder and wall by an irregular series of large denticulations. The character of the first lateral saddle and first lateral lobe is very much like that of the suture of *M. tobini*, *M.*

freemani, and the specimen from Nevada collected by N. J. Silberling from the base of the Star Peak Group, Humboldt Range, Nevada (Fig. 31C). It differs from these species in the greater elaboration and length of the remainder of the suture. The measurements of the holotype of *D. terbunicum* are: Diameter 43.0?, Width 12.0?, Height 21.8, Umbilicus 7.8 mm (the second specimen of this species mentioned by Arthaber is not in the collection of the Paleontological Institute, Vienna, and is presumed lost).

With some misgivings I include in *M. terbunicum*, *Meekoceras radiosum*,—Arthaber (non Waagen). This species has the same general shell form as *M. terbunicum* (compare Pl. 16, figs. 7, 8 and Pl. 18, figs. 9, 10) except for being more involute. The dimensions of this specimen are: Diameter 45.0?, Width 13.0?, Height 24.0?, Umbilicus 3.6? mm. The suture had been exposed by grinding and the pattern reproduced by Arthaber is not at all a correct representation. One can never be absolutely sure in cases like this but it appears that the suture is actually like that of the holotype of *M. terbunicum*. Thus on the basis of conch form and probable nature of the suture, this species is considered a synonym of *M. terbunicum*.

In the fauna from Chios, the Renzes (1948: 51) record one specimen as being conspecific with *D. terbunicum* Arthaber. The measurements of this specimen (Renz and Renz, 1948: pl. 1, figs. 7–7b) are as follows:

	D	W	H	U	W/D	H/D	U/D
NHMB J13692	42.0	14.2	20.3	8.3	33.8	48.3	19.8

In addition, the Renzes assigned another specimen to *D. nopcsanum* Arthaber var. *involuta* Renz and Renz (1948: 52, pl. 1, figs. 5–5a). The measurements of this species are as follows:

	D	W	H	U	W/D	H/D	U/D
NHMB J13694	28.8	10.7	13.7?	7.2	37.2	47.6?	25.0

The Albanian specimens of *D. nopcsa-*

num have rounded venters, the Chios specimen has a truncate, flattened venter and is merely a smaller specimen of *terbunicum*.

The Chios collection contained two specimens which the Renzes assigned to a new species of *Stacheites*—*S. dionysi*. The measurements of these two specimens are as follows:

	D	W	H	U	W/D	H/D	U/D
NHMB J13689	34.8	11.4	16.4	8.1	32.8	47.1	23.3
(Renz and Renz, 1948: pl. 1, fig. 6)							
NHMB J13690	45.8	?	21.2	10.4	?	46.3	22.7
(Renz and Renz, 1948: pl. 1, fig. 8)							

The conch form of *S. dionysi* is identical to that of *Metadagnoceras terbunicum*; the only difference between these forms is in the slightly greater individualization of the second lateral lobe (Fig. 31G), a difference I can hardly consider of specific significance and surely not of generic rank. Preparation of the suture in these specimens preserved in hard red limestone is very difficult, and is generally done by acid etching or grinding. Also, with only four specimens assigned to these three different species (and two genera), it is hardly justifiable to put such importance on minor differences in the suture. All three of the species are considered to be conspecific with *Metadagnoceras terbunicum* (Arthaber).

The Albanian and Chios specimens assigned to *terbunicum* have flattened venters. Silberling (personal communication) has a specimen from the Star Peak Formation, Nevada, that also has a flattened venter. This specimen is an incomplete phragmocone of approximately 44 mm in diameter. The other species of *Metadagnoceras* have low, arched venters to more highly vaulted venters. Considering the state and nature of preservation of the Albanian and Chios specimens assigned here to *terbunicum*, I believe they are all incomplete and immature specimens. It is, of course, uncertain as to what the character of the venter is like on a mature individual. As it is now interpreted, in

conch form this species is convergent to *Stacheites* but differs significantly in its suture.

Occurrence. *Subcolumbites* fauna of Albania and Chios.

Repository. Arthaber's (1911) figured type (pl. 21(5), fig. 10; Pl. 16, figs. 7, 8 of this report) is in the Paleontological Institute, University of Vienna. A second specimen indicated by Arthaber (1911: 242) is apparently lost. The Chios specimens are in the Natural History Museum, Basel, and are as follows: holotype *Dagnoceras nopesanum* var. *involuta* Renz and Renz (1948: pl. 1, fig. 5) NHMB J13694; unfigured specimen NHMB J13833; holotype *Stacheites dionysi* Renz and Renz (1948: pl. 1, fig. 6) NHMB J13689; paratype (pl. 1, fig. 8) NHMB J13690; unfigured paratypes NHMB J13691; plesio-type *Dagnoceras terbunicum* (pl. 1, fig. 7) NHMB J13692; unfigured specimens NHMB J13693.

Genus *Balkanites* Ganev, 1966

Type species, *Balkanites tabulatus* Ganev, 1966

Conch compressed with flat lateral areas and broad flat venter. Ventral shoulders weakly rounded. Umbilicus small, about 20 percent the diameter of the conch. Umbilical wall nearly vertical, umbilical shoulders weakly rounded. Conch smooth with no ornamentation. Suture goniatic consisting of a single large, smooth, lateral lobe with indication of the beginning of a second lobe at the umbilical shoulder. Ganev did not include a drawing of the suture in his report but he kindly sent me a photo of the specimen, plus a plaster cast which clearly shows the suture.

This is indeed a unique Scythian ammonoid and is an addition to the fairly large number of endemic genera which characterize the Werfen fauna. Ganev allied his new genus to *Dagnoceras* primarily on the basis of the single large lateral lobe. In this relationship I concur as being the most logical on the basis of

the data available. In *Dagnoceras* the venter is rounded and the lobe denticulated.

Balkanites tabulatus Ganev

Balkanites tabulatus Ganev, 1966: 24, pl. 2, figs. 1a-d.

Discussion of this species is given above.

Occurrence. Campil Member of Werfen Formation, perhaps as exotic blocks, Luda-Kamčija region of eastern Bulgaria.

Repository. Holotype (and only specimen) in Geological Institute of the Bulgarian Academy of Science; plaster cast in MCZ.

Genus *Nordophiceras* Popov, 1961

Type species, *Ceratites euomphalus* Keyserling, 1845

Nordophiceras euomphalus (Keyserling)

Plate 47, figures 6-8; Text-figure 32

Ceratites euomphalus Keyserling, 1845: 171, pl. 3, figs. 7-9; Middendorff, 1860: 248, pl. 3, figs. 7-9; Eichwald, 1868: 1039.

Meekoceras euomphalum,—Mojsisovics, 1882: 214; Waagen, 1895: 239, 246; Diener, 1915: 191.

Xenodiscus euomphalus,—Mojsisovics, 1886: 76, pl. 11, fig. 7.

Nordophiceras euomphalus,—Popov, 1961: 39.

Xenodiscus karpinskii Mojsisovics, 1886: 75, pl. 11, fig. 13.

Meekoceras (Gyronites) karpinskii,—Diener, 1915: 196.

Nordophiceras karpinskii,—Popov, 1961: 41, pl. 25, fig. 6; Vozin and Tikhomirova, 1964: 50, pl. 27, fig. 2.

Nordophiceras contrarius Popov, 1962a: 177.

Meekoceras contrarius Popov, 1962a: 185, pl. 3, fig. 7, text-fig. 8.

Meekoceras? contrarium,—Vozin and Tikhomirova, 1964: 55, pl. 30, fig. 3, text-fig. 9a.

Popov (1961) selected *Xenodiscus karpinskii* Mojsisovics (1886: 75, pl. 11, fig. 13) as the type species of his genus *Nordophiceras*. At the same time he included within that genus *Ceratites euomphalus* Keyserling (1845: 171, pl. 3, figs. 7-9). The latter species differs from *X. karpinskii* in having a slightly more inflated whorl section. The author has available four topotype specimens of *Nordophiceras*

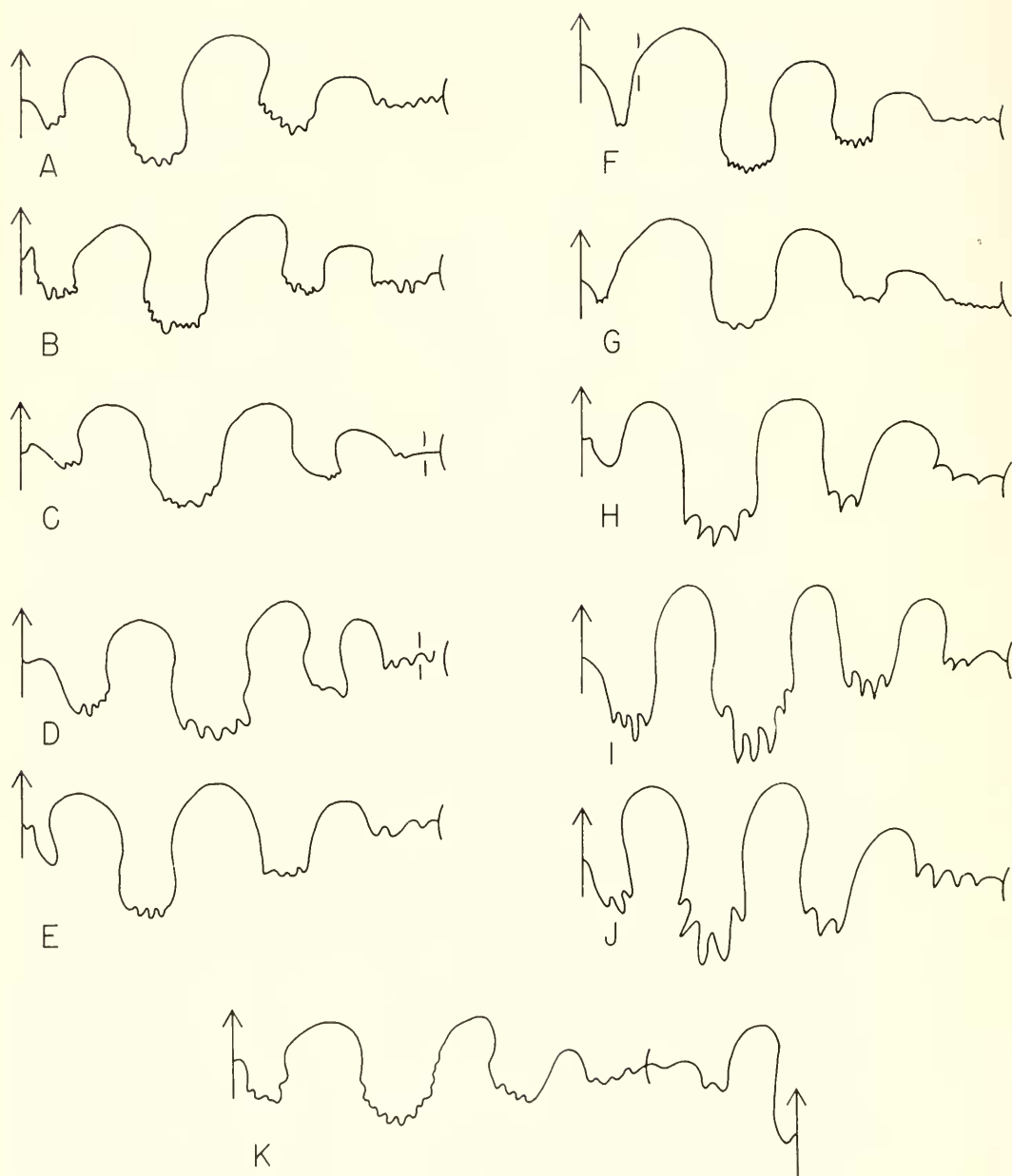


Figure 32. Diagrammatic representation of the suture of: A–C, *Nordaphiceras euomphalus* (Mojsisavics), from *Dieneroceras* Zone, northern Siberia; A, topotype,—Papov (1961: 39, fig. 6e), at a whorl height of 8 mm; B, topotype (MCZ 8670a), at a diameter of 50 mm; C, topotype (MCZ 8670b), at a diameter of 26 mm; D, holotype *Nordaphiceras contrarius* (Papov 1962a: fig. 8), *Dieneroceras* Zone, northern Siberia, at a whorl height of 20 mm; E, holotype *Nordaphiceras alexeevae* Papov (1961: 39, fig. 6c), from *Dieneroceras* Zone, eastern Taymyr, Siberia, at a whorl height of 15 mm; F, *Nordaphiceras jacksoni* (Hyatt and Smith), from *Columbites* fauna, Montpelier Canyon, southeast Idaho (MCZ 9572), at a diameter of 36 mm; G, paratype of *Prionolobus jacksoni* Hyatt and Smith (1905: pl. 62, fig. 16), from *Columbites* fauna, Paris Canyon, southeast Idaho, at a diameter of 45 mm (USNM 75292c); H, paratype *Meekoceras* (Submeekoceras) *compressum* Chao (1959: fig. 46a), from *Subcolumbites* fauna, Kwangsi, China, at a whorl height of 15 mm; I, holotype *Meekoceras* (Submeekoceras)

karpinskii identified by Dr. Popov. Examination of these specimens and of the illustrations in Mojsisovics (1886: pl. 11, fig. 7) clearly shows that these two so-called species cannot be distinguished. The combining of these two species thus makes *euomphalus* the type species of *Nordophiceras*.

Two of the Siberian topotypes in the collections of the Museum of Comparative Zoology are illustrated here on Plate 47, figures 6–8. The conch is moderately involute, compressed, with a rounded venter. The flanks are broadly convex and the umbilical shoulders rounded. The suture consists of two lateral lobes and a serrated lobe on the umbilical shoulder and wall. The sutures of two of the topotypes in the collection and that reproduced by Popov (1961: fig. 6e) are shown on Figure 32A–C. The conch is smooth except for sinuous growth lines.

Associated with this species in the Olenek fauna is a closely related species, *N. alexeevae* Popov, which differs in the presence of closely spaced fine, prosiradiate ribs on the inner whorls and more widely spaced, thin ribs on the outer whorls. In nearly all other aspects these two species are identical. A much closer relationship exists with *Nordophiceras jacksoni* (Hyatt and Smith) from the *Columbites* fauna of southeastern Idaho. The basic plan of the smooth conch and the suture is remarkably similar. The Idaho fauna has yielded a fairly large number of specimens which gives some appreciation of the variations in conch proportions (Fig. 33); this kind of data is lacking for the Siberian species described here. It is very possible that study of a large collection of the Siberian *N. euomphalus* could estab-

lish that *N. jacksoni* is a synonym; for the moment at least it seems best to keep the forms separate. It is because of this very close relationship with *N. jacksoni* that I believe *Meekoceras contrarius* is a synonym of *N. euomphalus*. The main difference in these species lies in the degree of involution. However, the difference in umbilical diameters lies well within the variation of this parameter in the populations of *N. jacksoni* from southeast Idaho. The other species of *Nordophiceras* in the *Columbites* fauna of Idaho are ornamented forms more related to *N. alexeevae*.

This species is also quite similar to *Nordophiceras planorbis* (Waagen) (Kummel, 1966: 397) from the Salt Range of West Pakistan from an upper Scythian horizon. The basic architecture of the conch is most similar; however, the Salt Range species is known from very few and generally poorly preserved specimens.

Occurrence. Mojsisovics' specimens are from the region of the mouth of the Olenek River, those described by Popov (1961) are from his *Dieneroceras* Zone in eastern Taymyr, Chernokhrebetnaya River.

Repository. Topotype specimens MCZ 9655 (Pl. 47, fig. 6), MCZ 8680 (Pl. 47, figs. 7, 8), MCZ 6107, 9656.

Nordophiceras alexeevae Popov

Text-figure 32

Nordophiceras alexeevae Popov, 1961: 39, pl. 25, fig. 7.

Nordophiceras olenekensis Popov, 1961: 40, pl. 12, fig. 8.

This species from northern Siberia is of particular interest because it is another form closely related to a species in the *Columbites* fauna of southeastern Idaho. In fact, because the Idaho fauna has yielded

←

loluense Choo (1959: fig. 45d), from *Subcolumbites* fauna, Kwangsi, China, at a whorl height of 12 mm; J, holotype *Meekoceras* (*Submeekoceras*) *longiseptatum* Choo (1959: fig. 46c), from *Subcolumbites* fauna of Kwangsi, at a whorl height of 22 mm; K, holotype *Nordophiceras olenekensis* Popov (1961: 40, fig. 6d), from *Dieneroceras* Zone, northern Siberia, at a whorl height of 12 mm.

a fairly large number of specimens, the data on that species (*N. pilatum*) have aided greatly in the interpretation of this Siberian species. It should be pointed out that Popov had available only one specimen of *N. alexeevae* and six specimens of *N. olenekensis*.

This species is essentially of the same conch morphology, that is in compression, involution, etc., as the associated *N. euomphalus*, except that on the inner whorls there are fine, closely spaced prosiradiate ribs which on the outer whorls are more widely spaced. The two species of Popov differ only in the degree of this ornamentation. *Nordophiceras pilatum* from the *Columbites* fauna of southeastern Idaho has a similar pattern of ornamentation. The large number of specimens in the Idaho collection clearly show a broad range of variation in the degree of intensity of ornamentation. The suture is illustrated on Figure 32E, K.

Occurrence. *Dieneroceras* Zone of Popov (1961), eastern Taymyr and the delta of the Lena River, northern Siberia.

Nordophiceras pseudosimplex n. sp.

Arctoceras simplex,—Popov (non Mojsisovics), 1961: 67, pl. 18, fig. 1; Vozin and Tikhomirova, 1964: 55, pl. 29, fig. 1.

Arctoceras simplex Mojsisovics (1886) was established for specimens which are the inner, juvenile whorls of *Arctoceras blomstrandii* (Lindström), and is of mid-Seythian *Owenites* Zone age (Kummel, 1961). The specimen Popov (1961) assigned to *Arctoceras simplex* is not at all comparable. Popov's specimen is more evolute, has flattened, more or less parallel, lateral areas. Popov (1961) states his specimen has smooth inner whorls but that one specimen had widely spaced radial ribs which disappeared on the body chamber. The ribs are not apparent on Popov's illustration. The suture is said to be ceratitic but this is not borne out by the published text-figure.

Needless to say that much more data are needed, but we can be sure that this specimen is not conspecific with *Arctoceras simplex* but rather is allied to such forms as *Nordophiceras euomphalus* from the underlying *Dieneroceras* Zone of Popov. It is, likewise, quite similar to *Nordophiceras planorbis* (Waagen) from the Narmia Member of the Mianwali Formation in the Salt Range.

Occurrence. *Olenekites* Zone in basin of Olenek River, northern Siberia.

Nordophiceras planorbis (Waagen)

Lecanites planorbis Waagen, 1895: 278, pl. 39, fig. 3.

Meekoceras (Gyronites) planorbis,—Diener, 1915: 197.

Nordophiceras planorbis,—Kummel, 1966: 397, pl. 4, figs. 1–3.

New illustrations and descriptions of the type specimens and two topotype specimens have been published by Kummel (1966). This is the only record of *Nordophiceras* for the Tethyan region.

Occurrence. Narmia Member, Mianwali Formation, Chhidru Nala, Salt Range, West Pakistan.

Repository. Holotype GSI 7226; topotypes MCZ 9611, 9612.

Nordophiceras jacksoni (Hyatt and Smith) Plate 47, figures 1–5; Plate 48, figures 1–4; Text-figures 32, 33

Prionolobus jacksoni Hyatt and Smith, 1905: 151, pl. 151, figs. 11–21; Krafft and Diener, 1909: 40, 41.

Meekoceras jacksoni,—Diener, 1915: 192.

Ophiceras jacksoni,—Smith, 1932: 49, pl. 62, figs. 11–21.

This species is abundantly represented in the *Columbites* beds exposed around the north end of Bear Lake, southeastern Idaho. The conch is smooth, evolute, compressed, with a rounded venter. The measurements of 48 specimens are given on Table 41 and plotted on Figure 33. These data show that there is only a moderate amount of variation in evolution

TABLE 41. MEASUREMENTS OF *NORDOPHICERAS JACKSONI* (HYATT AND SMITH) FROM *COLUMBITES* FAUNA, BEAR LAKE REGION, SOUTHEASTERN IDAHO.

	D	W	H	U	W/D	H/D	U/D		D	W	H	U	W/D	H/D	U/D
1.	62.0	14.2	20.7	25.1	22.9	33.4	40.5	25.	25.6	7.1	11.5	7.0	27.7	44.9	27.3
2.	61.0?	14.4	21.8	23.3	23.6?	35.7?	38.2?	26.	25.3	7.2	9.6	9.0	28.5	37.9	35.6
3.	55.7	12.2	21.0	20.0	21.9	37.7	35.9	27.	25.2	7.2	11.1	6.8	28.5	44.0	26.9
4.	50.4	10.8	20.4	15.3	21.4	40.5	30.4	28.	24.6	6.5	10.7	6.2	26.4	43.5	25.2
5.	47.0	11.0	18.4	15.0	23.4	39.1	31.9	29.	24.6	6.3	11.5	5.4	25.6	46.7	21.9
6.	45.3	11.4	18.3	13.5	25.1	40.4	29.8	30.	24.0	7.2	10.5	6.4	30.0	43.8	26.7
7.	44.4	11.5	16.2	16.7	25.9	36.5	37.6	31.	21.1	6.5	8.7	6.6	30.8	41.2	31.3
8.	44.2	10.6	17.5	12.5	23.9	39.6	28.3	32.	20.1	6.0	8.4	6.5	29.9	41.8	32.3
9.	43.0	9.7	18.2	11.0	22.6	42.3	25.6	33.	20.0	5.4	8.2	5.3	27.0	41.0	26.5
10.	39.1	9.6	15.4	12.5	24.6	39.4	31.9	34.	19.3	5.7	8.2	5.7	29.5	42.5	29.5
11.	36.2	8.5	14.4	11.9	23.5	39.8	32.9	35.	19.2	5.7	8.1	5.7	39.7	42.2	29.7
12.	33.8	8.2	14.7	9.0	24.3	43.5	26.6	36.	18.9	6.5	7.4	5.8	34.4	39.2	30.7
13.	32.6	?	13.0	9.9	?	39.9	30.4	37.	18.2	5.1	7.0	5.9	28.0	38.5	32.4
14.	32.5	8.4	13.7	9.3	25.8	42.2	28.6	38.	18.1	5.8	7.3	6.1	32.0	40.3	33.7
15.	31.0	8.3	13.3	8.7	26.8	42.9	28.1	39.	18.0	6.0	7.7	6.1	33.3	42.8	33.9
16.	31.0	8.5	12.4	10.2	27.4	40.0	32.9	40.	17.5	6.0	7.4	5.7	34.3	42.2	32.6
17.	29.0	7.2	10.5	10.7	24.8	36.2	36.9	41.	16.7	5.3	6.4	5.7	31.7	38.3	34.1
18.	28.4	7.6	11.2	9.1	26.7	39.4	32.0	42.	16.3	5.7	6.4	5.1	34.9	39.3	31.3
19.	28.0	7.0?	12.3	8.1	25.0?	43.9	28.9	43.	15.8	5.0	6.3	5.3	31.6	39.9	33.5
20.	27.5	7.3	11.8	7.6	26.5	42.9	27.6	44.	13.7	4.8	5.4	4.7	35.0	39.4	34.3
21.	27.2	7.0	11.2	9.3	25.7	41.2	34.2	45.	11.5	4.3	5.0	4.0	37.4	43.5	34.8
22.	26.2	7.2	11.4	7.0	27.5	43.5	26.7	46.	11.3	4.2	4.4	3.7	37.2	38.9	32.7
23.	26.0	7.5	10.8	7.8	28.8	41.5	30.0	47.	10.8	4.3	4.3	3.6	39.8	39.8	33.3
24.	26.0	6.8	9.8	9.2	26.1	37.7	35.4	48.	10.1	4.4	3.9	3.2	43.6	38.6	31.7

1. Plesiotype, MCZ 9565 (Pl. 47, fig. 2).

3. Plesiotype, MCZ 9564 (Pl. 47, fig. 1).

4. Holotype, USNM 75292a (Pl. 48, figs. 3, 4).

8. Paratype, USNM 75292c (Pl. 48, figs. 1, 2).

15. Plesiotype, MCZ 9567 (Pl. 47, fig. 4).

24. Plesiotype, MCZ 9568 (Pl. 47, fig. 5).

29. Paratype, USNM 75292d (Smith, 1932: pl. 62, figs. 17, 18).

45. Plesiotype, MCZ 9566 (Pl. 47, fig. 3).

All other specimens are from the *Columbites* fauna, Thaynes Formation at Montpelier Canyon and Hot Springs, southeastern Idaho.

or in the dimensions of the whorls. There is a tendency toward greater opening of the umbilicus with growth. Two of the largest specimens of this species are illustrated on Plate 47, figures 1, 2; both of these specimens show larger relative diameters of the umbilicus than more juvenile forms.

The suture is shown in Figure 32F, G, and consists of two denticulated lateral lobes and an auxiliary lobe on the umbilical shoulder and wall that is generally irregularly straight and denticulated. The smooth conch bears only fine growth lines.

Nordophiceras jacksoni is very similar to *Nordophiceras euomphalus* (Keyserling) from northern Siberia. The similarity is so

close that I consider it possible these two species may be conspecific. The Siberian species is known from very few specimens, and no data are available on the variation within those populations. For the moment it seems best to keep the two species separate.

Nordophiceras jacksoni and *N. euomphalus* are the smooth species of this genus; in contrast to these two species there are two other described species—*N. alexeevae* and *N. pilatum*—which are very similar in general conch morphology but bear some ornamentation in the form of ribs.

Occurrence. *Columbites* fauna, Thaynes Formation, at Paris Canyon, Montpelier

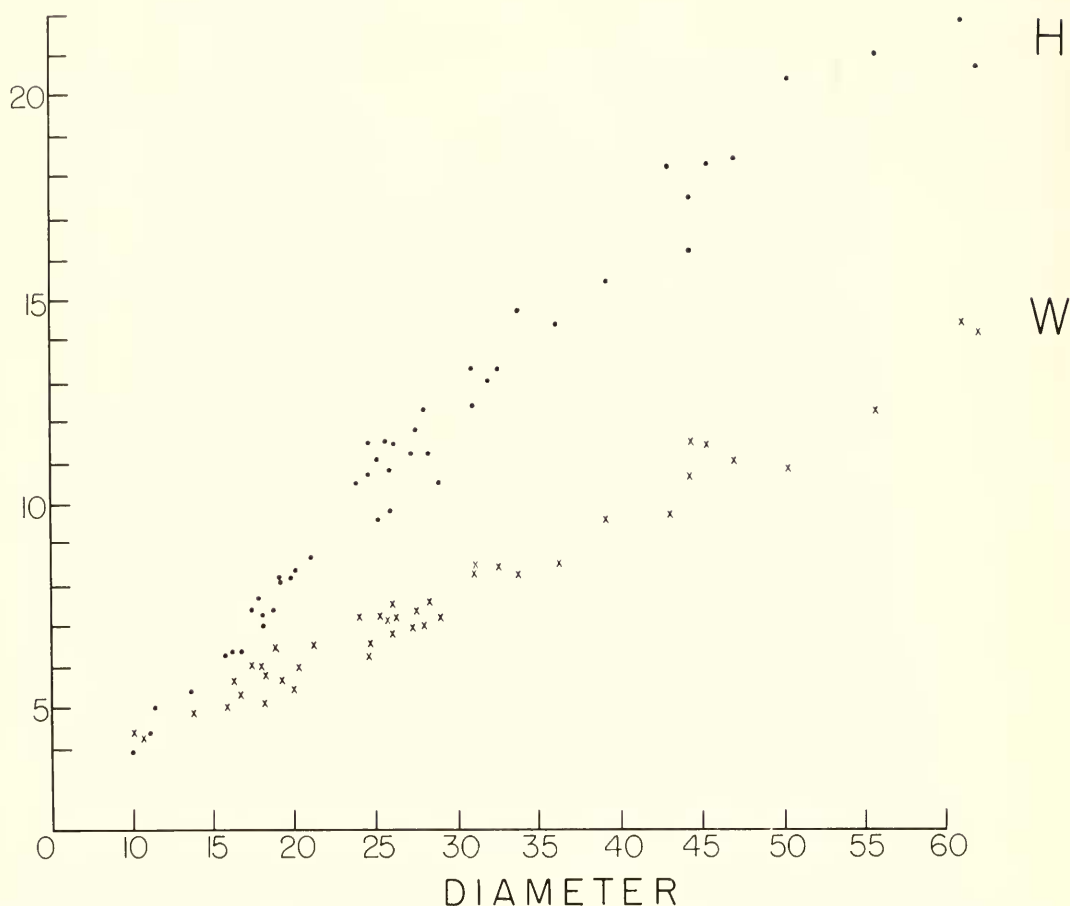


Figure 33. Variation in whorl height (H) and whorl width (W) of *Nordophraceras jacksoni* (Hyatt and Smith), from *Columbites* fauna, Bear Lake region, southeast Idaho. The data on this graph are from Table 41.

Canyon, and Hot Springs, southeastern Idaho.

Repository. Holotype, USNM 75292a (Pl. 48, figs. 3, 4); paratypes, USNM 75292b (Smith, 1932: pl. 62, fig. 14), USNM 75292c (Pl. 48, figs. 1, 2), USNM 75282d (Smith, 1932: pl. 62, figs. 17, 18), USNM 75292e (Smith, 1932: pl. 62, figs. 19–21); plesiotypes, MCZ 9564 (Pl. 47, fig. 1), MCZ 9565 (Pl. 47, fig. 2), MCZ 9566 (Pl. 47, fig. 3), MCZ 9567 (Pl. 47, fig. 4), MCZ 9568 (Pl. 47, fig. 5); suture specimen, MCZ 9572 (fig. 32F); unfigured specimens from Montpelier Canyon MCZ 9570, from Hot Springs MCZ 9571.

Nordophraceras pilatum (Hyatt and Smith)
Plate 46, figures 2, 3; Plate 49, figures 1–8; Plate 50, figures 1–11; Plate 51, figures 1–5; Text-figures 34, 35

Meckoceras pilatum Hyatt and Smith, 1905: 144, pl. 63, figs. 3–9; Diener, 1915: 193; Smith, 1932: 59, pl. 63, figs. 7–13.

Meckoceras curticoatum Smith, 1932: 56, pl. 48, figs. 21–30.

Meckoceras micromphalus Smith, 1932: 58, pl. 49, figs. 5–11.

Meckoceras sanctorum Smith, 1932: pl. 49, figs. 1–4.

This is one of the more abundant species in the *Columbites* fauna of southeastern Idaho. Basically this species has an involute, compressed conch, with a rounded

venter, and bears prosiradiate ribs of varying strength. There are considerable variations in the degree of involution, inflation of the whorls, and ornamentation. The measurements of 42 specimens, including the primary types, are given on Table 42 and plotted on Figure 35.

All of Smith's (1932) collection from the *Columbites* fauna of southeastern Idaho came from one locality, namely Paris Canyon. In the description of the four species now included in *N. pilatum*, Smith (1932) made a direct comparison only between his *Meekoceras curticostratum* and *Meekoceras pilatum*; he states, "*Meekoceras curticostratum* has some resemblance to *M. pilatum*, with which it is associated, differing in the wider umbilicus, more compressed whorls, weaker and more numerous ribs." Smith considered his *Meekoceras micromphalus* to be closely related to *Meekoceras keyserlingi* Mojsisovics (now the type species of *Boreomeekoceras* Popov, 1961) from the Olenek region of Siberia. He considered his *Meekoceras sanctorum* to be closely related to *Meekoceras affine* Mojsisovics also from the Olenek region of Siberia. Even though Smith (1932) did not discuss the specific criteria upon which he separated his species of this group, it is clear that the intensity of ribbing, degree of whorl inflation, and degree of involution were important considerations. On examination of a fairly large suite of specimens it is readily apparent that the primary types of *Meekoceras sanctorum* (Pl. 49, figs. 1-3) and *Meekoceras micromphalus* (Pl. 50, figs. 7-11) are juvenile specimens. Both these specimens are characterized by rather small umbilici; examination of large mature specimens, such as the holotype of *Meekoceras curticostratum* (Pl. 50, figs. 1, 2) and the new plesiotypes (Pl. 51, figs. 1-5), clearly shows how the umbilicus increases in relative diameter with growth. This is well shown on the graph of Figure 34. The umbilical region also reflects another facet of variation and this is in the nature

of the umbilical shoulder and wall. Generally, the umbilical shoulder is fairly acutely rounded with a sloping umbilical wall; at the same time, there are forms with slightly more rounded umbilical shoulders and lower, sloping umbilical walls. Among the large number of specimens before me one can recognize a continuous gradation from one type to the other.

The most conspicuous variation within this species is in the intensity of the ribbing. Typically the ribbing pattern consists of fine, prosiradiate ribs on the inner volutions that become more widely spread and more subdued with growth of the shell. In some forms the ribbing on the inner volutions is extremely faint and on the outer volutions there is nothing more than a vague bundling of the growth lines (see Pl. 49, fig. 1). On the other hand the ribbing on the inner volutions may be coarse and more widely spaced (as in the paralectotype of *N. pilatum*, Pl. 49, figs. 4-6) but on the mature volutions these become inconspicuous broad folds (as in the lectotype of *N. pilatum*, Pl. 49, figs. 7, 8). Finally, there are forms (as the specimen of Pl. 50, fig. 2) in which the ribs continue to increase in intensity throughout growth. The photographs here of the primary types and of a few additional plesiotypes illustrate the range of variation in ornamentation to be observed in the collection. Needless to say, there is complete gradation from one type to the other.

The venter is another area in which one can observe extensive variation. This may be from forms with acutely rounded venters to forms with more broadly rounded venters. Generally, the acutely rounded venters are found in the more juvenile specimens.

This species is very similar to *N. alexeevae* Popov from northern Siberia. Both these species are the ornamented nordophicerids associated in their respective faunas with smooth species, *euomphalus* in Siberia, and *jacksoni* in southeast Idaho.

The sutures are illustrated on Figure 34.

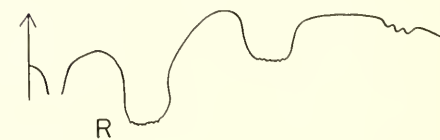
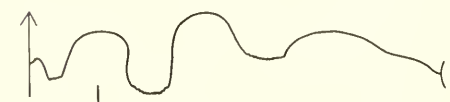
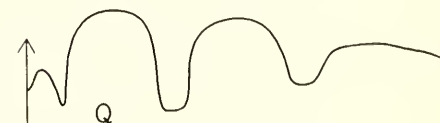
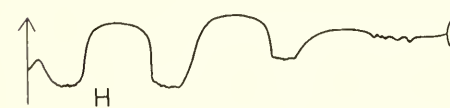
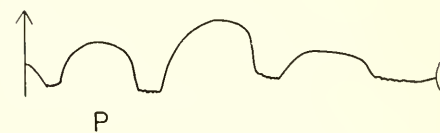
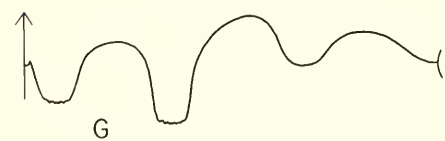
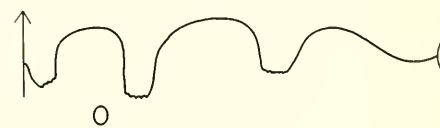
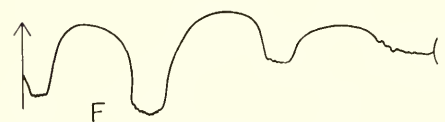
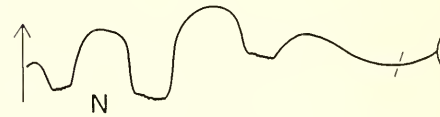
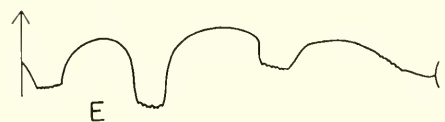
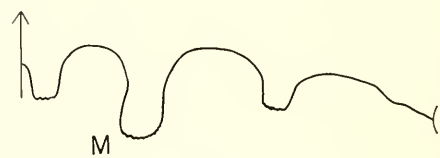
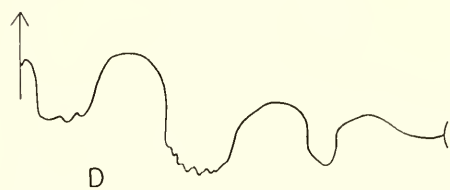
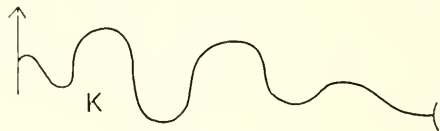
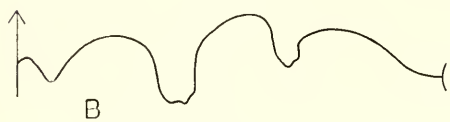
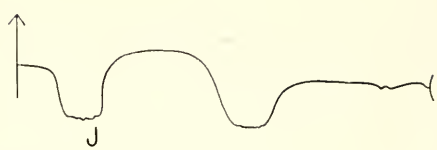


TABLE 42. MEASUREMENTS OF *NORDOPHICERAS PILATUM* (HYATT AND SMITH) FROM THE *COLUMBITES* FAUNA AROUND BEAR LAKE, SOUTHEASTERN IDAHO.

	D	W	H	U	W/D	H/D	U/D		D	W	H	U	W/D	H/D	U/D
1.	87.0	17.8	37.2	21.4	20.5	42.8	24.6	22.	42.7	9.4	18.8	12.0	22.0	44.0	28.1
2.	78.0	15.6	33.4	18.0	20.0	42.8	23.1	23.	42.5	8.8	17.7	11.7	20.7	40.0	27.5
3.	73.7	16.0	30.5	20.6	21.7	41.4	27.9	24.	41.8	9.2	19.0	9.6	22.0	45.5	22.9
4.	72.5	13.7	29.0	21.0	18.9	40.0	28.9	25.	41.5	11.0	21.0	6.4	26.5	50.6	15.4
5.	70.2	16.0	30.2	20.0	22.8	43.0	28.5	26.	40.4	8.3	17.7	9.2	20.5	43.8	22.8
6.	68.5	13.8	28.8	19.0	20.1	42.0	27.7	27.	39.2	9.4	16.7	11.6	23.9	42.6	29.6
7.	60.0	15.8	29.0	12.3	26.3	48.3	20.5	28.	38.4	8.1	16.8	10.0	21.1	43.8	26.0
8.	57.8	12.0	22.6	16.7	20.8	39.1	28.9	29.	37.9	8.5	19.5	5.7	22.4	51.5	15.0
9.	57.4	13.2	24.8	14.2	22.9	43.2	24.7	30.	35.8	7.2	15.7	8.8	20.1	43.9	24.6
10.	57.3	11.7	26.9	11.2	20.4	46.9	19.5	31.	35.7	7.8	19.0	5.0	21.8	53.2	14.0
11.	55.0	?	22.3	16.2	?	40.5	29.5	32.	34.6	8.0	15.7	7.8	23.1	45.4	66.8
12.	54.4	9.5	23.0	15.0	17.5	42.3	27.6	33.	33.7	7.5	17.0	5.3	22.3	50.4	15.7
13.	54.4	10.8	23.7	13.0	19.9	43.6	23.9	34.	33.4	7.2	15.4	6.5	21.6	46.1	19.5
14.	53.4	10.2	21.4	16.8	19.1	40.1	31.5	35.	33.2	?	15.2	8.0	?	45.8	24.1
15.	53.1	10.8	23.5	13.7	20.3	44.2	25.8	36.	32.3	6.5	13.9	8.9	20.1	43.0	27.6
16.	52.0	11.0	22.7	13.2	21.2	22.5	25.4	37.	31.4	6.8	14.2	7.3	21.7	45.2	23.2
17.	48.7	9.2	19.8	9.0	18.9	40.7	18.5	38.	30.3	7.2	16.0	5.2	23.8	52.8	17.2
18.	48.7	10.6	21.2	13.0	21.8	43.5	26.7	39.	27.3	6.3	12.6	6.1	23.1	46.2	22.3
19.	48.6	10.2	21.4	13.7	20.9	44.0	28.2	40.	21.0	4.6	10.4	4.1	21.9	49.5	19.5
20.	46.7	9.6	21.0	10.0	20.6	44.9	21.4	41.	16.6	5.6	7.6	4.4	33.7	45.8	26.5
21.	43.3	12.1	20.7	9.4	27.9	47.8	21.7	42.	12.5	3.4	6.3	2.5	27.2	50.4	20.0

3. Holotype, *Meekoceras curticoatum* Smith (1932: pl. 48, figs. 21, 22), USNM 74990a.

5. Plesiotype, MCZ 9542 (Pl. 51, figs. 2, 3).

6. Plesiotype, MCZ 9541 (Pl. 51, fig. 5).

7. Syntype, *Meekoceras pilatum* Hyatt and Smith (1905: pl. 63, figs. 7, 8), USNM 75294a.

14. Plesiotype, MCZ 9539 (Pl. 51, fig. 1).

15. Plesiotype, MCZ 9540 (Pl. 51, fig. 4).

20. Paratype, *Meekoceras sanctorum* Smith (1932: pl. 49, figs. 3, 4), USNM 74991b.21. Syntype, *Meekoceras pilatum* Hyatt and Smith (1932: pl. 63, figs. 10–13), USNM 75294b.25. Holotype, *Meekoceras micromphalus* Smith (1932: pl. 49, figs. 5–8), USNM 74992a.29. Holotype, *Meekoceras sanctorum* Smith (1932: pl. 49, figs. 1, 2), USNM 74991a.31. Paratype, *Meekoceras curticoatum* Smith (1932: pl. 48, figs. 23, 24), USNM 74990b.

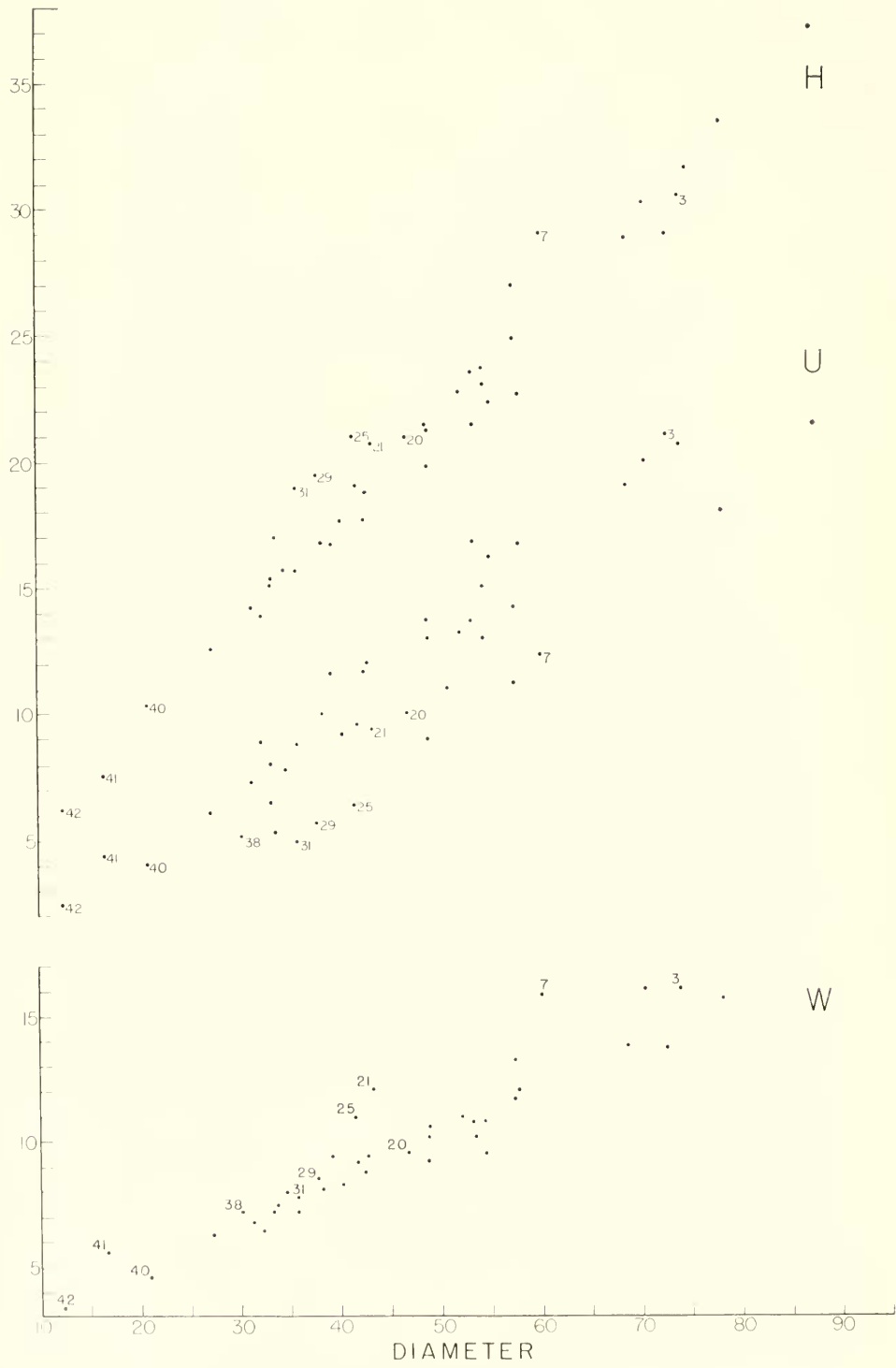
33. Plesiotype, MCZ 9544 (Pl. 46, fig. 3).

34. Plesiotype, MCZ 9543 (Pl. 46, fig. 2).

38. Paratype, *Meekoceras curticoatum* Smith (1932: pl. 48, figs. 25, 26), USNM 74990c.40. Paratype, *Meekoceras curticoatum* Smith (1932: pl. 48, figs. 27, 28), USNM 74990d.41. Paratype, *Meekoceras micromphalus* Smith (1932: pl. 48, figs. 9–11), USNM 74992b.42. Paratype, *Meekoceras curticoatum* Smith (1932: pl. 48, figs. 29, 30), USNM 74990e.All other specimens are from the *Columbites* fauna, Thaynes Formation at Hot Springs (MCZ 9546) and Montpelier Canyon (MCZ 9545), southeastern Idaho.

Figure 34. Diagrammatic representations of the sutures of *Nordophraceras pilatum* (Hyatt and Smith). A, from paratype of *Meekoceras micromphalus* Smith (1932: pl. 49, fig. 8), at a diameter of 17 mm (USNM 74992b); B, from paratype of *Meekoceras curticoatum* Smith (1932: pl. 48, fig. 24), at a diameter of 33 mm (USNM 74990b); C, from paratype of *Meekoceras sanctorum* Smith (1932: pl. 49, fig. 4), at a diameter of 29 mm (USNM 74991b); D, from lectotype of *Meekoceras pilatum* Hyatt and Smith (1905: pl. 63, fig. 9), at a diameter of 60 mm (USNM 75294a); E, at a diameter of 45 mm (MCZ 9573a); F, at a diameter of 31 mm (MCZ 9573b); G, at a diameter of 40 mm (MCZ 9573c); H, at a diameter of 42 mm (MCZ 9573d); I, at a diameter of 35 mm (MCZ 9573e); J, at a diameter of 45 mm (MCZ 9573f); K, at a diameter of 30 mm (MCZ 9573g); L, at a diameter of 52 mm (MCZ 9573h); M, at a diameter of 34 mm (MCZ 9573i); N, at a diameter of 40 mm (MCZ 9573j); O, at a diameter of 53 mm (MCZ 9573k); P, at a diameter of 41 mm (MCZ 9573l); Q, at a diameter of 26 mm (MCZ 9573m); R, at a diameter of 45 mm (MCZ 9573n).

All specimens from *Columbites* fauna, Thaynes Formation, southeastern Idaho; specimens A–D are from Paris Canyon, H and L from Hot Springs, the remaining specimens from Montpelier Canyon. All diameters given are approximate.



Occurrence. *Columbites* fauna, Thaynes Formation at Paris Canyon, Hot Springs, and Montpelier Canyon, southeastern Idaho.

Repository. Lectotype, *Meekoceras pilatum* Hyatt and Smith (1905: pl. 63, figs. 7–9) USNM 75294a; paralectotype (Hyatt and Smith, 1905: pl. 63, figs. 10–13) USNM 75294b; holotype, *M. curticostratum* Smith (1932: pl. 48, figs. 21, 22) USNM 74990a; paratypes (Smith, 1932: pl. 48, figs. 23, 24) USNM 74990b, (Smith, 1932: pl. 48, figs. 25, 26) USNM 74990c, (Smith, 1932: pl. 48, figs. 27, 28) USNM 74990d, (Smith, 1932: pl. 48, figs. 29, 30) USNM 74990e; holotype *M. sanctorum* Smith (1932: pl. 49, figs. 1, 2) USNM 74991a; paratype (Smith, 1932: pl. 49, figs. 3, 4) USNM 74991b; holotype *M. micromphalus* Smith (1932: pl. 49, figs. 5–8) USNM 74992a; paratype (Smith, 1932: pl. 49, figs. 9–11) USNM 74992b; plesiotypes MCZ 9539 (Pl. 51, fig. 1), MCZ 9542 (Pl. 51, figs. 2, 3), MCZ 9540 (Pl. 51, fig. 4), MCZ 9541 (Pl. 51, fig. 5), MCZ 9543 (Pl. 46, fig. 2), MCZ 9544 (Pl. 46, fig. 3); suture specimens MCZ 9573 a–n; unfigured specimens from Montpelier Canyon MCZ 9545; unfigured specimens from Hot Springs MCZ 9546.

***Nordophriceras compressum* (Chao)**
Text-figure 32

Meekoceras (*Submeekoceras*) *compressum* Chao, 1959: 140, 320, pl. 44, figs. 1–6, text-fig. 46a, b.
Meekoceras (*Submeekoceras*) *lolouense* Chao, 1959: 141, p. 320, pl. 10, figs. 7, 8, text-fig. 45d.
Meekoceras (*Submeekoceras*) *longiseptatum* Chao, 1959: 141, pl. 10, figs. 5, 6, text-fig. 46c.

The three species brought together here are based on specimens that come from the same horizon and locality; two of the species were based on one specimen each, the other on five specimens. Chao (1959) made no mention of the specific criteria he

used to differentiate these species. I can see no significant differences between any of these species. The sutures (Figs. 32H–J) are remarkably similar.

This is a smooth form of *Nordophriceras* of the general pattern of *euomphalus*, *pseudosimplex*, and *planorbis*. There are slight differences in conch form among these species but more than anything the suture is quite distinctive and the most useful in differentiating this species.

Occurrence. Limestone block containing a *Subcolumbites* fauna in Lolou village (Chao collection 542b) Kwangsi, China.

Genus *Pseudokymatites* Spath, 1934

Type species, *Kymatites svilajanus* Kittl, 1903

***Pseudokymatites svilajanus* (Kittl)**

Plate 62, figure 5, Text-figure 40

Kymatites svilajanus Kittl, 1903: 69, pl. 4, fig. 3; Diener, 1915: 181.

Pseudokymatites svilajanus.—Spath, 1934: 265, fig. 91; Kummel, in Arkell et al., 1957: L143, fig. 175, 6.

Kittl's type and only specimen of this species is incomplete, crushed, and at best of only fair preservation. It measures 63.5 mm in diameter, 13.02 mm for the width of the adoral whorl, 29.4 mm for the height, and the umbilicus is 12.3 mm in diameter. Spath (1934: 265) created a new genus for this species in his belief that it was probably a "smooth meekoceratid" with smooth lateral lobes. The goniatic nature of the lobes, however, is not at all certain. The specimen is weathered and the smooth nature of the lobes could well be the result of this. It is not possible to settle this question on the basis of the single specimen available. Speculations of the genetic relations of this form are pointless until the

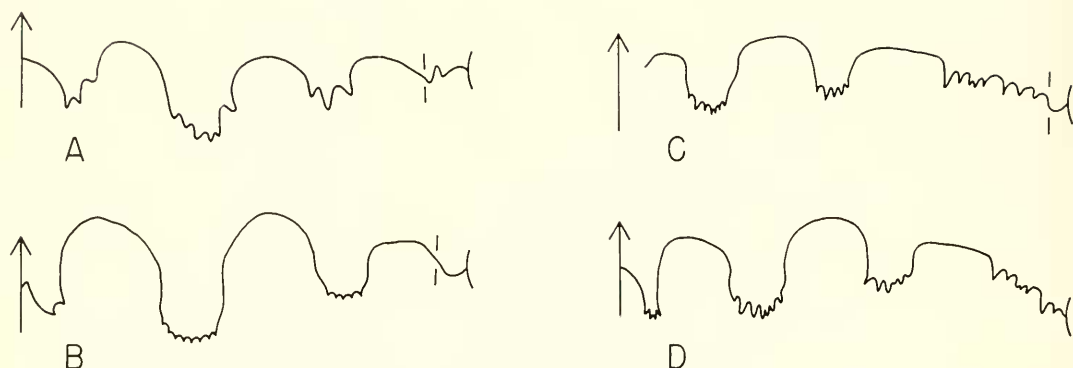


Figure 36. Diagrammatic representation of the suture of: A, *Arctomeekoceras rotundatum*,—Popov (1962a: fig. 9), from *Olenekites* Zone, northern Siberia, at a whorl height of 20 mm; B, *Arctomeekoceras* sp. indet. Kummel (1966: fig. 22E), from Narmia Member of Mianwali Formation, Surghar Range, West Pakistan, at a whorl height of 9 mm; C, D, two sutures of topotype specimen of *Boreomeekoceras keyserlingi* (Mojsisovics) from *Olenekites* Zone, northern Siberia, C, at a whorl height of 26.5 mm, D, at a whorl height of 15 mm (MCZ 8684).

basic morphological elements are better understood.

Occurrence. Werfen Formation, Muć, Dalmatia.

Repository. Natural History Museum, Vienna.

Genus *Arctomeekoceras* Popov, 1961

Type species, *Meekoceras rotundatum* Mojsisovics, 1886

Compressed, involute conchs, with narrowly rounded venters on earlier volutions tending to become more broadly rounded with age. Suture ceratitic with two lateral lobes and auxiliary series. The type and only species of the genus is known from the *Olenekites* fauna of Siberia. Indeterminate species have also been recorded from the upper part of the Lower Triassic succession in the Salt Range of West Pakistan (Kummel, 1966).

Arctomeekoceras rotundatum (Mojsisovics) Text-figure 36

Meekoceras rotundatum Mojsisovics, 1886: 83, pl. 10, fig. 16; Diener, 1915: 194.

Boreomeekoceras rotundatum,—Popov, 1961: 42.

Arctomeekoceras rotundatum,—Popov, 1962a: 187, pl. 1, figs. 1, 5, pl. 3, fig. 4

This is as yet an incompletely known species; Mojsisovics apparently had only

one specimen and Popov four specimens but the illustrations and descriptions are incomplete. The key feature of the genus and species is the broadening of the venter on the adoral whorls. The suture (Fig. 36A) has two serrated lateral lobes and a small auxiliary on the umbilical wall.

Occurrence. *Olenekites* Zone, Lena River delta and Olenek River, Siberia.

Arctomeekoceras sp. indet. (West Pakistan) Text-figure 36

Arctomeekoceras sp. indet. Kummel, 1966: 398, pl. 2, figs. 1–5.

Generally incomplete and poorly preserved specimens that appear to be much like the type species of this genus, but more material is needed from both faunas before a significant comparison can be made. The suture is shown on Figure 36B.

Occurrence. Narmia Member of Mianwali Formation in Salt Range and Surghar Range of West Pakistan.

Repository. MCZ 9584–9586, 9589, 9590–9592.

Genus *Boreomeekoceras* Popov, 1961 Type species, *Meekoceras keyserlingi* Mojsisovics, 1886

Involute, compressed conch, venter nar-

rowly rounded, flanks convergent. Suture ceratitic with two lateral lobes and extended auxiliary series. The type and only species of this genus is from the *Olenekites* fauna of the Olenek region, northern Siberia.

***Boreomeekoceras keyserlingi* (Mojsisovics)
Text-figure 36**

Meekoceras keyserlingi Mojsisovics, 1886: 81, pl. 10, figs. 13–15; Diener, 1915: 192; Spath, 1934: 158, 254.

Boreomeekoceras keyserlingi,—Popov, 1961: 42, pl. 10, fig. 4.

This is a unique species in the known late Scythian faunas because of its tightly involute lenticular conch; the illustrations by Mojsisovics (1886: pl. 10, figs. 13–15) and Popov (1961: pl. 10, fig. 4) are quite satisfactory. The suture, however, in neither of these publications is well represented. A topotype specimen is available and two sutures from this specimen are shown on Figures 36 C, D.

Occurrence. *Olenekites* Zone near mouth of Olenek River, northern Siberia.

Repository. The MCZ has one topotype specimen, S684.

Genus *Arctotiolites* Popov, 1963

**Type species, *Pseudotiolites menensis*
Popov, 1962**

***Arctotiolites menensis* (Popov)**

Pseudotiolites menensis Popov, 1962a: 178, pl. 2, fig. 4.

Arctotiolites menensis (Popov) 1963: 137.

This new genus and species was established on the basis of a single specimen. The illustration and description of the species leave much to be desired. The conch is moderately involute, compressed, and with an arched venter. The lateral areas bear sigmoidal folds which apparently end at the ventral shoulders in small nodes. The suture has two serrated lateral lobes and a serrated auxiliary lobe on the umbilical shoulder and wall.

On the basis of the nodes one is at first

tempted to think of this form as a tirolitid of some sort. However, the greater involution of the conch and the suture does not support such a conclusion. On the basis of the very incomplete data, it seems more probable that this form is related to *Nordophiceras*. The suture of *menensis* is very much like that of a typical *nordophicerid*. In addition, some species of *Nordophiceras* are ornamented with ribs.

Occurrence. *Olenekites* Zone, Olenek River basin, Mene River, northern Siberia.

Family NORITIDAE Karpinsky, 1889

Genus *Albanites* Arthaber, 1909

Type species, *Pronorites triadicus* Arthaber, 1908

***Albanites triadicus* (Arthaber)**

Plate 16, figures 3–6; Plate 17, figures 1–10; Plate 18, figures 7, 8; Plate 20, figures 7–9; Text-figure 37

Pronorites triadicus Arthaber, 1908: 264, pl. 11, figs. 4a–c; Arthaber, 1911: 204, pl. 17(1), figs. 8, 9; Diener, 1915: 231; C. Renz, 1928: 155; Kutassy, 1933: 624; Renz and Renz, 1947: 61; Renz and Renz, 1948: 84, pl. 14, figs. 14–14b. *Albanites triadicus*,—Spath, 1934: 275, fig. 95; Kummel, 1968b: 498, pl. 2, figs. 1–9.

Pronorites osmanicus Arthaber, 1911: 205, pl. 17(1), fig. 10; Diener, 1915: 231; C. Renz, 1928: 155.

Albanites osmanicus,—Spath, 1934: 276.

Pronorites cf. osmanicus,—Renz and Renz, 1947: 62; Renz and Renz, 1948: 86, pl. 15, figs. 6–6c.

Pronorites arbanus Arthaber, 1911: 205, pl. 17(1), figs. 11, 12; Diener, 1915: 230; Welter, 1922: 94, pl. 155, figs. 10–14; C. Renz, 1928: 155; Kutassy, 1933: 624; C. Renz 1945: 301; Renz and Renz, 1947: 61; Renz and Renz, 1948: 85, pl. 14, figs. 13–13b, 15–15b, pl. 15, figs. 5–5c. *Albanites arbanus*,—Spath, 1934: 277.

Pronorites arbanus var. *mediterranea* Renz and Renz, 1947: 62; Renz and Renz, 1948: 85, pl. 14, figs. 12–12b.

Pronorites spec. ind. ex aff. *arbanus*,—Welter, 1922: 95, pl. 155(1), fig. 9.

Anasibirites gracilis Kiparisova, 1947: 164, pl. 39, figs. 3, 4, text-figs. 60, 61.

Pronorites arbanus var. *sundaica* Renz and Renz, 1948: 85.

Albanites welteri Spath, 1934: 278.

Pronorites orientalis Renz and Renz, 1947: 62; Renz and Renz, 1948: 86, pl. 15, figs. 2–2b.

Pronorites schaubi Renz and Renz, 1947: 62, 78; Renz and Renz, 1948: 87, pl. 15, figs. 4-4a.

Pronorites schaubi var. *timorensis* Renz and Renz, 1948: 87.

Pronorites schaubi var. *kephalovuncensis* Renz and Renz, 1947: 62, 78; Renz and Renz, 1948: 87, pl. 15, figs. 3-3a.

Pronorites reicheli Renz and Renz, 1947: 62, 79; Renz and Renz, 1948: 88, pl. 15, figs. 1-1c.

Albanites danispanensis (Astakhova) 1960a: 143, pl. 34, figs. 4, 5; Astakhova, 1960b: 150.

Aspidites hasserti Arthaber, 1911: 249, pl. 21(5), fig. 16; Spath, 1934: 275.

Meekoceras (*Koninckites*) *hasserti*,—Diener, 1915: 198.

Dagnoceras komanum Arthaber, 1911: 242, pl. 21(5), fig. 11; Diener, 1915: 115; Smith, 1932: 65; Spath, 1934: 269, 275.

Pseudosibirites cf. *dichotomus* Waagen,—Arthaber, 1911: 254, pl. 22(6), fig. 8.

Anasibirites cf. *dichotomus*,—Arthaber, 1911: 273.

Sibirites cf. *dichotomus*,—Diener, 1915: 255.

The genus *Albanites* is a conspicuous member of the *Subcolumbites* fauna from Albania and Chios, from the Mangyshlak Peninsula, and from the *Prohungarites* fauna of Timor, but in none of these localities is the form particularly abundant. The genus is much better represented in Chios than in Albania, but the preservation of most of the specimens in these faunas often leaves much to be desired. It is factors of preservation and preparation of the Albanian specimens that have led to some of the misunderstanding about the genus. Examination of all the specimens in the Albania, Chios, and Timor collections leads me to conclude that they all represent a single species; there have been seven species and four variety names introduced for this group.

The holotype is a small specimen of only fair preservation; the lateral area and venter of the adoral quarter revolution has been ground and polished to expose the suture. The smoothness of the venter commented on by Arthaber (1911: 205) and Spath (1934: 277) is the result of this grinding and polishing. The dimensions of the holotype are given on Table 43, and the suture is shown on Figure 37. At the time he introduced the species *triadicus* in 1908, Arthaber had only one specimen. In 1911

TABLE 43. MEASUREMENTS OF *ALBANITES TRIADICUS* FROM THE *SUBCOLUMBITES* FAUNAS OF ALBANIA AND TIMOR, AND FROM BLOCK "E," NIFOEKOKO, TIMOR.

	D	W	H	U	W/D	H/D	U/D
1.	55.8	26.1	22.4	15.8	46.8	40.1	28.3
2.	53.3	18.7	23.4	12.8	35.1	43.9	24.0
3.	49.2	14.2	22.3	10.1	28.9	45.3	20.5
4.	49.0	15.5	22.7	11.8	31.6	46.3	24.1
5.	40.0?	16.5	16.2?	10.1	41.3?	40.5?	25.3?
6.	38.4	13.5	16.1	11.7	35.2	41.9	30.5
7.	34.8	14.1	16.4	7.2	40.5	47.1	20.7
8.	34.7	12.8	14.4	11.4	37.1	41.5	32.9
9.	31.0	10.1	11.7	10.7	32.6	37.7	34.5
10.	28.7	8.7	11.8	9.1	30.3	41.1	31.7
11.	28.4	10.8	12.4	7.3	38.0	43.7	25.7
12.	28.2	8.4	14.4	4.4	29.8	51.1	15.6
13.	27.7	8.7	11.2	8.4	31.4	40.4	30.3
14.	25.8	9.0	12.0	6.1	34.9	46.5	23.6
15.	25.7	10.8	12.4	6.4	42.0	48.2	24.9
16.	25.0	10.5	11.1	6.4	42.0	44.4	25.6
17.	24.6	7.7	12.4	4.0	31.3	50.4	16.3
18.	?	?	?	12.8	?	?	?

1. Holotype, *Pronorites reicheli* Renz and Renz (1948: pl. 15, fig. 1), NHMB J13809.
2. Plesiotype, *Pronorites* sp. ind. ex aff. *arbanus*,—Welter (1922: pl. 155(1), fig. 9), GPIBo W206.
3. Holotype, *Pronorites schaubi* Renz and Renz (1948: pl. 15, fig. 4), NHMB J13805.
4. Type specimen, *Pronorites schaubi* var. *kephalovuncensis* Renz and Renz (1948: pl. 15, fig. 3), NHMB J13808.
5. Type specimen, *Pronorites osmanicus* Arthaber (1911: pl. 17(1), fig. 10), PIUV.
6. Plesiotype, *Pronorites arbanus*,—Renz and Renz (1948: pl. 14, fig. 15), NHMB J13795.
7. Syntype, *Albanites welteri* Spath (= *Pronorites arbanus*,—Welter, 1922: pl. 155, figs. 10-12), GPIBo W205b.
8. Type specimen, *Pronorites arbanus* var. *mediterranea* Renz and Renz (1948: pl. 14, fig. 12), NHMB J13800.
9. Plesiotype, *Pronorites arbanus*,—Renz and Renz (1948: pl. 14, fig. 13), NHMB J13796.
10. Holotype, *Pronorites orientalis* Renz and Renz (1948: pl. 15, fig. 2), NHMB J13801.
11. Plesiotype, *Pronorites triadicus*,—Renz and Renz (1948: pl. 14, fig. 14), NHMB J13793.
12. Syntype, *Albanites welteri* Spath (= *Pronorites arbanus*,—Welter, 1922: pl. 155, figs. 13, 14), GPIBo W205a.
13. Plesiotype, *Pronorites arbanus*,—Renz and Renz (1948: pl. 15, fig. 5), NHMB J13797.
14. Holotype, *Pronorites triadicus* Arthaber (1908: pl. 11, fig. 4), PIUV.
15. Plesiotype, *Pronorites* cf. *osmanicus*,—Renz and Renz (1948: pl. 15, fig. 6c), NHMB J13804.
16. Plesiotype, *Pronorites* cf. *osmanicus*,—Renz and Renz (1948: pl. 15, figs. 6-6b), NHMB J13803.
17. Lectotype, *Pronorites arbanus* Arthaber (1911: pl. 17 (1), figs. 11 a-d), PIUV.
18. Paralectotype, *Pronorites arbanus* Arthaber (1911: pl. 17(1), figs. 12 a, b), PIUV.

Specimens of numbers 5, 14, 17, 18 are from the *Subcolumbites* fauna of Albania; those of 2, 7, 12 are from the *Albanites* fauna of Timor; and the remaining specimens are from the *Subcolumbites* fauna of Chios.

he had one additional specimen to which, however, no specific reference was made. This specimen is illustrated here on Plate 17, figures 3, 4, and the dimensions are given on Table 43. As can be seen, it is a small juvenile form with a fairly inflated whorl section. The venter is broadly arched with rounded ventral shoulders; there are numerous weak ridges across the venter which disappear just above the ventral shoulders. This specimen differs from the holotype mainly in its slightly more inflated conch.

In 1911, Arthaber introduced two additional species for this group from the Albanian *Subcolumbites* fauna. For *Pronorites osmanicus* Arthaber (1911: 205, pl. 17(1), fig. 10; Pl. 17, figs. 5, 6 of this report) the author states he had six specimens. The illustrated specimen is the only one preserved in the collections of the Paleontological Institute, University of Vienna. There are two topotypes in the British Museum (Natural History). Arthaber's illustrated specimen is selected as the lectotype; this illustration is one of the least successful in Arthaber's monograph as it is highly modified. The specimen is all phragmocone, distorted, and generally of poor preservation. Much of the lateral area of the conch has been ground and polished to expose the suture. The adoral quarter volution bears prominent cross ridges, but the remainder of the venter is too poorly preserved to show this feature. The radial ribs on the flanks of the penultimate volution are not present on the specimen. The dimensions of the specimen are given on Table 43. This species was said to differ from *A. triadicus* in the presence of cross ridges on the venter and in slight differences in the suture (Fig. 37c). The smooth venter of the holotype of *A. triadicus* is due to grinding and polishing. The ridges are clearly present on the small second specimen assigned by Arthaber to *A. triadicus* (Pl. 17, figs. 3, 4).

Pronorites arbanus (Arthaber, 1911: 205, pl. 17(1), figs. 11, 12) was based on three

specimens of which two were illustrated and are still preserved. This species was said to differ from *A. osmanicus* in its more compressed conch, greater involution, and slightly different proportions of the suture. The measurements of these two specimens are given on Table 43; the smaller of the two specimens (Pl. 17, figs. 9, 10) was selected by Spath (1934: 278) as lectotype. The paralectotype (Pl. 17, figs. 1, 2) has weak falcoid folds on the adoral half volution. This species is clearly only a compressed variant and is conspecific with the remaining forms of *Albanites* from Albania.

The collections from the *Subcolumbites* fauna of Chios studied by Renz and Renz (1948) contain approximately 50 specimens of *Albanites* which they placed in six species and two varieties. One species (*arbanus*) is represented by perhaps 20 specimens, two species (*triadicus* and *schaubi*) were recognized on eight specimens each, one species (*orientalis*) on four specimens, one species (cf. *osmanicus*) on two specimens, and one species and two varieties on the basis of a single specimen each. The measurements of the prepared and more complete specimens of *Albanites* in the Renz and Renz collections from Chios are given on Table 43. The basic difference between all these species lies in the degree of compression of the conch, in degree of ornamentation, and in degree of involution of the conch. Examination of the Chios collection indicates to me that these characters are highly gradational and the numerous species names are merely labels applied to possessors of a particular morphological character within a completely gradational complex. Much of the discussion of these species by Renz and Renz (1948) is confusing and out of date due to their oversight of some of the earlier literature.

There has been some question and doubt as to whether the two specimens from Timor, described by Welter (1922) as *Pronorites arbanus*, are the inner whorls of the same species that Welter described as *Pronorites* spec. ind. ex aff. *arbanus*. Exami-

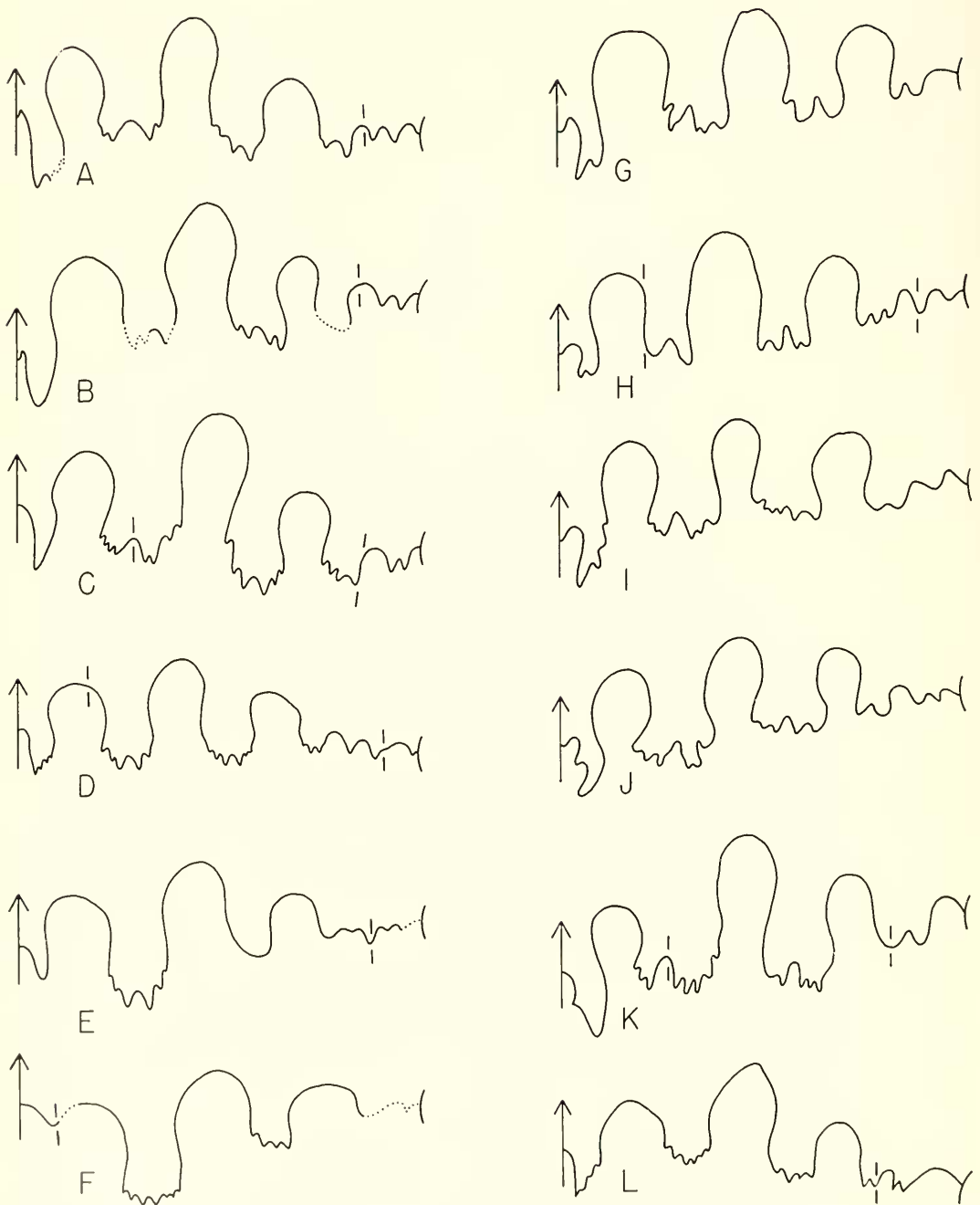


Figure 37. Diagrammatic representation of the sutures of *Albanites triadicus* (Arthaber). A, holotype (Arthaber, 1911: pl. 17(1), fig. 8), redrawn suture at diameter of 30 mm; B, paratype (Arthaber's second and smaller specimen of *triadicus*), at a diameter of 18 mm; C, figured type of *A. osmanicus* (Arthaber, 1911: pl. 17(1), fig. 10), redrawn suture at a diameter of 38 mm; D, lectotype of *A. arbanus* (Arthaber, 1911: pl. 17(1), fig. 11), redrawn suture at a diameter of 23 mm; E, holotype of *Dagnoceras komanum* Arthaber (1911: pl. 21(5), fig. 11), redrawn suture at a diameter of 18 mm; this specimen has been ground and polished so that the fine details of the sutural elements have been destroyed; F, type

nation of Welter's original specimens leaves no doubt on this question. Spath (1934: 278) came to the same conclusion on examination of a fine series of specimens in the British Museum (Natural History). Spath (1934) recognized the "external resemblance" to the Albanian *A. arbanus*, but felt because there were differences in the suture that a new name was needed, and he introduced the name *A. welteri*. The differences in the suture, however, are no more than what one can observe within the Albanian and Chios faunas.

Albanites danispanensis (Astakhova, 1960a) was stated to resemble *A. osmanicus* Arthaber and *A. arbanus* Arthaber, differing, however, in size of the umbilicus, ornamentation, and details of the suture. On the basis of the illustrations and descriptions of this species, none of these differences appear to be significant against the range of variation known to exist in the Albanian and Chios forms. This species from the Mangyshlak Peninsula can be considered as a representative of *A. triadicus*.

Finally, there is a group of species from the *Subcolumbites* fauna, based on very poorly preserved specimens; an inspection of the types suggests inclusion in this species. First, there is the specimen for which Arthaber (1911: 242, pl. 21(5), fig. 11; Pl. 18, figs. 7, 8 of this report) proposed the name *Dagnoceras komanum*. This specimen measures 27 mm in diameter, 7.2 mm for the width of the adoral whorl, 12.7 mm for the height, and 6.3 mm for the diameter of the umbilicus. The whorls are compressed, converging slightly

toward a flattened venter. Both the ventral and umbilical shoulders are sharply rounded. On the adoral one-third volution the ventral shoulders bear diagonal ribs; the venter is not well enough preserved to tell just how these ribs cross the venter. In the better preserved specimen of *A. triadicus*, cross ridges on the venter are connected with weak radial ribs on the flanks. I am inclined to believe that the diagonal, projecting ribs on the ventral shoulder of the holotype of *Dagnoceras komanum* are at least partially due to the poor state of preservation of the specimen and possibly to slight crushing. Thus the difference in the rib pattern from that of the type specimen of *A. triadicus* is more apparent than real.

The specimen Arthaber (1911: pl. 22(4), figs. 8a-c; Pl. 20, figs. 7-9 of this report) assigned to *Pseudosibirites* cfr. *dichotomus* Waagen I believe to be essentially identical to the specimen he assigned to *Dagnoceras komanum*. This conclusion is made taking into account the poor and slightly different preservations of these two specimens. The lateral ribs are more conspicuous, as is the chevron aspect of the ribs across the venter. The specimen is, however, slightly crushed laterally.

The sutures of these species are shown on Figure 37E, F. First of all, it can be seen that they are essentially identical; any differences can readily be explained by excessive grinding of the specimen. Secondly, it can be seen that these two sutures are essentially identical to the sutures of the specimens of *Albanites* so far known from the Albanian *Subcolumbites* fauna.

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specimen of *Pseudosibirites* cfr. *dichotomus*,—Arthaber (1911: pl. 22(6), fig. 8), redrawn suture at a diameter of 18 mm; G, plesio-type of *A. arbanus*,—Renz and Renz (1948: pl. 14, fig. 13b), at a diameter of 20 mm (NHMB J13796); H, plesio-type of *A. arbanus*,—Renz and Renz (1948: pl. 14, fig. 15b), at a diameter of 25 mm (NHMB J13795); I, plesio-type of *A. arbanus* var. *mediterranea* (Renz and Renz, 1948: pl. 14, fig. 12b), at a diameter of 24 mm (NHMB J13800); J, plesio-type (Renz and Renz, 1948: pl. 14, fig. 14b), at a diameter of 17 mm (NHMB J13793); K, holotype of *Pronorites reicheli* Renz and Renz (1948: pl. 15, fig. 1c), at a diameter of approximately 40 mm (NHMB J13809); L, paratype of *Albanites danispanensis* (Astakhova, 1960a: fig. 10), at a diameter of 30 mm.

Specimens of figures A-F from *Subcolumbites* fauna of Albania, those of G-K from *Subcolumbites* fauna of Chios; specimen of figure L from the Mangyshlak Peninsula.

Considering all the factors available for these two "species," I believe it best to consider them as conspecific with *Albanites triadicus* of the same fauna. The differences in the rib pattern on the venter are difficult to evaluate on the basis of the sample available. No purpose is served in assigning these two forms to different genera.

Further, I suggest that the two specimens Arthaber (1911: 249, pl. 21(5), fig. 16) assigned to *Aspidites hasserti* Arthaber are poorly-preserved representations of *A. triadicus*. Arthaber's figured type (Pl. 16, figs. 3, 4) measures 44.6 mm in diameter, 14.3 mm for the width of the adoral whorl, 20.8 mm for the height, and 10.5 mm for the diameter of the umbilicus. In addition to being poorly preserved, the specimen has been ground and polished in places. The basic plan of the suture is that of *A. triadicus*. The smaller unfigured specimen referred to by Arthaber (1911: 249) is illustrated here on Plate 16, figures 5, 6. This specimen measures 22.4 mm in diameter, 6.6 mm for the width of the adoral whorl, 11.7 mm for the height and 2.5 mm for the diameter of the umbilicus. In both these specimens the basic conch form and suture show them to be close to *A. triadicus*; what differences are apparent can be readily explained as due to the state of preservation or due to grinding and polishing.

Occurrence. The species is known from the *Subcolumbites* fauna of Albania, Chios, and Afghanistan, from the *Prohungarites* fauna of Timor, and from the *Columbites* Zone of Astakhova (1960a, b) on the Mangyshlak Peninsula.

Repository. The Paleontological Institute, University of Vienna contains the holotype, and the second specimen referred to as *Pronorites triadicus* by Arthaber (1911: 204; figured here Pl. 17, figs. 3, 4), the lectotype of *Pronorites osmanicus* Arthaber, the lectotype and paralectotype of *Pronorites arbanus* Arthaber. This institution also contains the holotype of *Dagnoceras komanum* Arthaber, the figured specimen

of *Pseudosibirites* cfr. *dichotomus* Waagen, and the lectotype and paralectotype of *Aspidites hasserti* Arthaber. The Natural History Museum, Basel, contains the following specimens: plesiotype *Pronorites triadicus*,—Renz and Renz (1948: pl. 14, fig. 14) NHMB J13793; unfigured specimens NHMB J13794; plesiotypes *Pronorites arbanus*,—Renz and Renz (1948: pl. 14, fig. 15) NHMB J13795, (pl. 14, fig. 13) NHMB J13796, (pl. 15, fig. 5) NHMB J13797; unfigured specimens from Maradovuno NHMB J13798, from Kephlovuno NHMB J13799; figured specimens *Pronorites arbanus* var. *mediterranea* Renz and Renz (1948: pl. 14, fig. 12) NHMB J13800; holotype *Pronorites orientalis* Renz and Renz (1948: pl. 15, fig. 2) NHMB J13801; unfigured paratypes NHMB J13802; figured specimens of *Pronorites* cf. *osmanicus* Renz and Renz (1948: pl. 15, fig. 6–6b) NHMB J13803, (pl. 15, fig. 6c) NHMB J13804; holotype *Pronorites schaubi* Renz and Renz (1948: pl. 15, fig. 4–4a) NHMB J13805; unfigured paratypes from Maradovuno NHMB J13806, from Kephlovuno NHMB J13807; figured specimen of *Pronorites schaubi* var. *kephlovunensis* Renz and Renz (1948: pl. 15, fig. 3–3a) NHMB J13808; holotype *Pronorites reicheli* Renz and Renz (1948: pl. 15, fig. 1–1c) NHMB J13809. The three specimens studied by Welter (1922) are in the Paleontological Institute, Bonn University; additional topotype specimens are in the British Museum (Natural History); specimens from Afghanistan MCZ 10136, 10145, 10152, 10153, 10156, 10168.

Family PRIONITIDAE Hyatt, 1900

Genus *Hemiprionites* Spath, 1929

Type species, *Goniodiscus typus* Waagen, 1895

Hemiprionites costatus Popov

This species is based on a single specimen which unfortunately is incompletely described and illustrated. On the basis of the data available, I can only concur in

Popov's generic assignment of this species. The genus *Hemiprionites* had previously been known only from the *Anasibirites* Subzone of the *Owenites* Zone. In this mid-Scythian horizon it is a very common and quite distinctive form. Popov (1961) states this species is associated with *Inyoites eiekitensis* Popov (here assigned to *Subvishnuites*) and *Dieneroceras nikabitensis* Popov (here considered to be a synonym of *D. demokidovi* Popov). Both these associated species are generalized forms, and it is possible all of these species belong to the *Owenites* Zone and are not equivalent to the *Columbites* Zone as are most of the faunas assigned by Popov (1961) to his *Dieneroceras* Zone.

Occurrence. Olenek River basin, northern Siberia.

Family SIBIRITIDAE Mojsisovics, 1896

Genus *Sibirites* Mojsisovics, 1886

Type species, *Ceratites eichwaldi* Keyserling, 1845

Sibirites eichwaldi (Keyserling)

Ceratites eichwaldi Keyserling, 1845: pl. 3, fig. 14; Eichwald, 1868: 1040; Mojsisovics, 1882: 41.

Sibirites eichwaldi,—Mojsisovics, 1886: 59, pl. 10, figs. 1–9; Frech, 1905: pl. 28, fig. 10; Diener, 1915: 255; Spath, 1934: 342, 344, figs. 116d, e; Kiparisova, 1947: 164; Popov, 1961: 31, pl. 14, fig. 2; Vozin and Tikhomirova, 1964: 63, pl. 38, figs. 1, 2.

Sibirites cf. *eichwaldi*,—Popov, 1961: 31, pl. 14, fig. 6.

Sibirites pretiosus Mojsisovics, 1886: 61, pl. 10, fig. 10; Diener, 1915: 256; Spath, 1934: 343, figs. 116a–c; Popov, 1961: 32, pl. 13, fig. 1a; Vozin and Tikhomirova, 1964: 64, pl. 38, fig. 3.

Sibirites ind. aff. *pretiosus* Mojsisovics, 1886: 61, pl. 10, figs. 11, 12; Diener, 1915: 256.

Sibirites grambergi Popov, 1961: 31, pl. 14, fig. 1.

Parasibirites grambergi (Popov), 1962a: 181, pl. 1, fig. 3.

Sibirites grambergi var. *rariaculeatus* Popov, 1961: 31, pl. 14, fig. 5.

Parasibirites rariaculeatus Popov, 1962a: 182, pl. 1, fig. 2.

Sibirites grambergi var. *mixta* Popov, 1961: 31, pl. 14, fig. 7.

Parasibirites mixtus Popov, 1962a: 183, pl. 1, fig. 4.

Sibirites subpretiosus Popov, 1961: 33, pl. 14, fig. 8.

Parasibirites subpretiosus (Popov), 1962a: 181.

The large number of species brought together here reflect the usual typological treatment of trachyostracan ammonites. The "species" differ in degree of ornamentation, that is, in the relative prominence of ribs, nodes, etc. These species have now been recorded from a number of localities in northern Siberia, especially at and around the Olenek region. Neither Mojsisovics (1886) nor Popov (1961, 1962a) had particularly large collections to study nor did they present much data on the variability within their samples. I shall make the prediction that when large collections of *Sibirites* from the Olenek region become available they will show a complete gradational series from lesser to stronger ornamented forms, and that the ontogenetic development will be found to be also highly variable. I look upon *Sibirites* as having the same range of genetic variability as is seen, for instance, in *Anasibirites kingianus* or *Columbites parisiensis*, both species known by large samples.

Occurrence. *Olenekites* Zone, northern Siberia, Olenek River, Verkhoyan region, Kolyma River basin, and eastern Taymyr.

Sibirites renzi n. sp.

Plate 24, figures 6–9

Anasibirites aff. *anguloso* (Waagen),—Renz and Renz, 1947: 60; Renz and Renz, 1948: 35, pl. 11, figs. 10, 11.

The Renzes (1948) listed only two specimens of this species, but there are in the collections four additional paratypes. The preservation of all the specimens leaves much to be desired. The shape of the conch, degree of involution, and pattern of ornamentation place this species in *Sibirites*. The ribs are slightly interrupted in their passage over the venter; in *Anasibirites* the ribs are continuous over the venter.

Occurrence. *Subcolumbites* fauna, Chios.

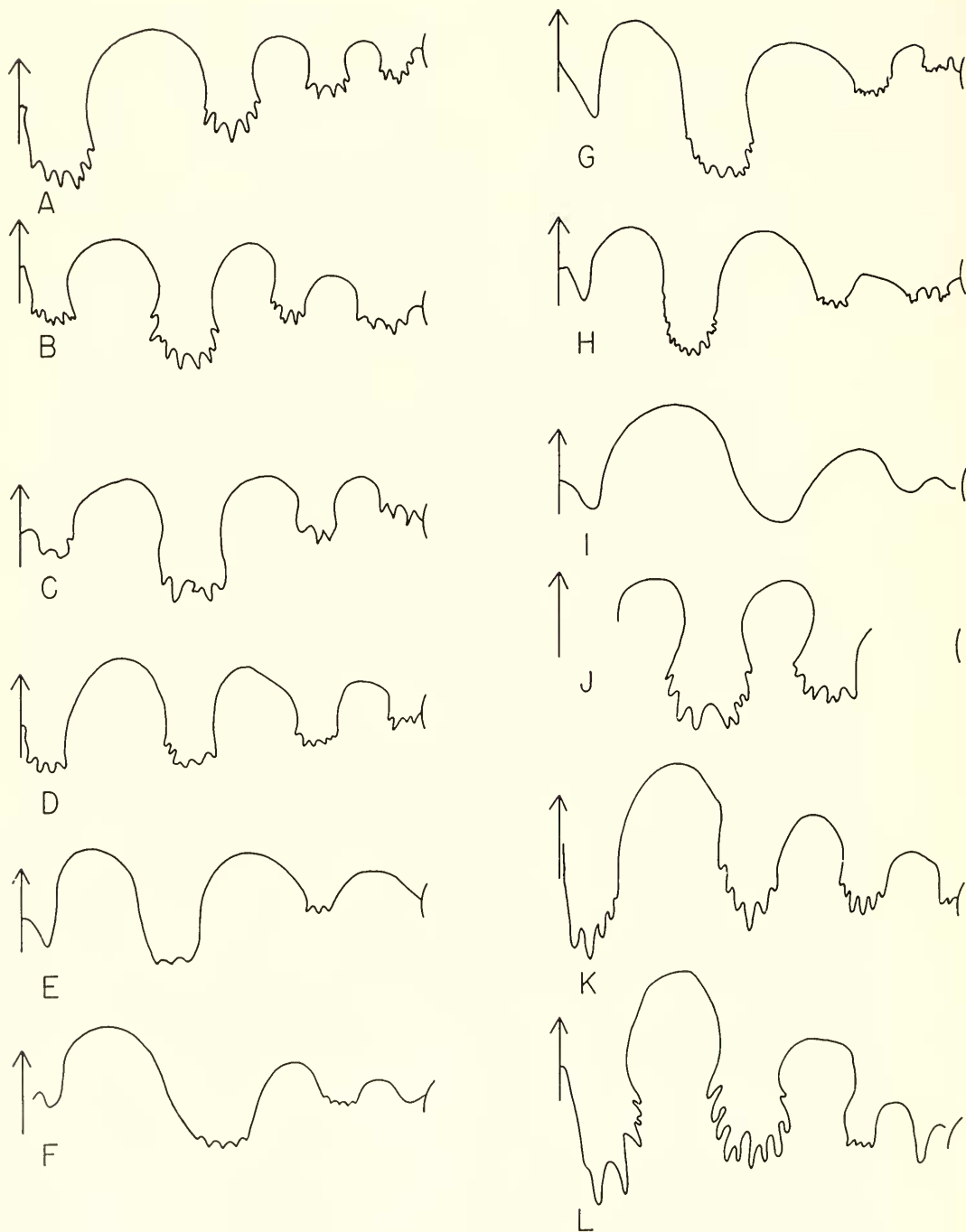


Figure 38. Diagrammatic representation of the suture of: A, *Keyserlingites subrobustus* (Mojsovics, 1886: pl. 4, fig. 2c), at a diameter of approximately 85 mm; B, *Keyserlingites middendorffi* (Keyserling)—Mojsovics (1886: pl. 3, fig. 1c), at a diameter of approximately 100 mm; C, *Ceratites nikitini* Mojsovics (1888: pl. 1, fig. 13c), at a diameter of approximately 25 mm; D, *Ceratites bungei* Mojsovics (1888: pl. 1, fig. 14c), at a diameter of approximately 50 mm; E, holotype Key-

Repository. Holotype, Renz and Renz (1948: pl. 11, fig. 10) NHMB J13623; paratype, Renz and Renz (1948: pl. 11, fig. 11) NHMB J13624; Pl. 24, figs. 6, 7 of this report, NHMB J19551; Pl. 24, figs. 8, 9 of this report, NHMB J19552; unfigured paratypes NHMB J13625.

Genus *Keyserlingites* Hyatt, 1900

Type species, *Ceratites subrobustus*
Mojsisovics, 1885

There are now five late Scythian species of this genus confined to the circum-Arctic region and in western North America. Four of these species (*subrobustus*, *middendorffi*, *bearlakensis*, and *bearriverensis*) are confined to the *Prohungerites* Zone, and one species (*stephensoni*) is from the *Columbites* Zone. On the basis of studies on several well preserved specimens of *Keyserlingites subrobustus* from British Columbia and Ellesmere Island, Tozer (1965a) has been able to clarify the relations between *Keyserlingites* and *Durgaites*. Tozer's suggestion, however, that the Himalayan "*Durgaites*" *dieneri* and the Timor "*D.*" *angustecostatus* may be upper Scythian in age rather than Anisian, as concluded by Diener (1907, 1912), Spath (1934) and Welter (1915), is here rejected. This question has been fully discussed in the introductory chapter (p. 348).

Keyserlingites subrobustus (Mojsisovics)

Plate 26, figures 6, 7; Text-figure 38

Ceratites middendorffi Keyserling, 1845: pl. 2, fig. 4.

Ceratites subrobustus Mojsisovics, 1885: 155, pl. 6, fig. 3; Mojsisovics, 1886: 44, pl. 4, fig. 2,

pl. 5, figs. 1a, b, pl. 6, fig. 1; Noetling, in Frech, 1905: 194, 200, pl. 28, fig. 5a, b.

Keyserlingites subrobustus,—Hyatt, 1900: 559; Diener, 1915: 172; Spath, 1934: 355, fig. 119a-c; Kummel, 1961: 521; Popov, 1961: 55, pl. 15, fig. 1; Tozer, 1965a: 31, pl. 5, fig. 1, pl. 6, figs. 1, 2, pl. 7, figs. 1-3, pl. 8, figs. 1, 2; Tozer, 1965b: 5.

Robustites subrobustus,—Philippi, 1901: 556.

Keyserlingites cf. *subrobustus*,—Frebold, 1929a: 12, pl. 2, figs. 8, 9; Tozer, 1962, pl. 4, figs. 6a-c. *Ceratites bungei* Mojsisovics, 1888: 8, pl. 1, fig. 14; Spath, 1934: 356.

Keyserlingites bungei,—Diener, 1915: 178; Popov, 1961: 54.

This species has recently been extensively described and illustrated by Tozer (1965a) on the basis of specimens from Ellesmere Island and British Columbia which have contributed much to our knowledge of this most interesting form. *Ceratites bungei* (Fig. 38D) is believed to be based upon a juvenile specimen of *K. subrobustus*. The differences in the two Arctic species of *Keyserlingites* are largely in the nature of the whorl section. This species has a subquadrate whorl section, whereas *middendorffi* is a much more compressed form. *Keyserlingites bearlakensis* n. sp. has a suture quite similar to *subrobustus* (Fig. 38A) but a simpler pattern of ornamentation with only a single set of lateral bullae. The other species of *Keyserlingites* in the *Prohungerites* Zone of southeast Idaho, *bearriverensis*, is a compressed form like the Siberian *middendorffi*.

Occurrence. The type specimens came from the *Olenekites* Zone at the mouth of the Olenek River, Siberia. The species is also known from Spitsbergen at Cape

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serlingites bearriverensis n. sp., at a diameter of 50 mm; F, paratype *Keyserlingites bearriverensis* n. sp., at a diameter of 9.5 mm (MCZ 9521); G, holotype *Keyserlingites bearlakensis* n. sp., at a whorl height of 24 mm (MCZ 9516); H, paratype *Keyserlingites bearlakensis* n. sp., at a whorl height of 25 mm (MCZ 9523); I, paratype *Keyserlingites bearlakensis* n. sp., at a diameter of 7.3 mm (MCZ 9518); J, holotype *Keyserlingites stephensoni* n. sp. at a diameter of 190 mm; K, holotype *Ceratites subrobustus* Diener (1897: pl. 19, fig. 2) (= *Keyserlingites dieneri*), at a diameter of approximately 110 mm; L, *Keyserlingites angustecostatus* Welter (1915: 108, fig. 12).

Specimens of figures A-D from *Olenekites* Zone, Olenek River region, Siberia; of E-I from Upper Thaynes Formation, Hammond Creek, southeast Idaho; J, from Thoynes Formation, Fort Hall Indian Reservation presumably from *Columbites* Zone; K, lower Anisian, Himalayas and Tibet; L, lower Anisian, Nifoeokoko, Timor.

Thordson (Frebold, 1929a), and from the *Grippia* beds, Botneheia, south of Sassanfiord (Tozer, 1962). On Ellesmere Island the species is present in the Blaa Mountain Formation and the Blind Fiord Formation, and in British Columbia in the Toad Formation in the Halfway River area (Tozer, 1965a).

Repository. The Siberian specimens are in the Central Geological Museum, Leningrad. The Spitsbergen specimen reported by Frebold (1929a) is in the Paleontological Museum, Oslo; another Spitsbergen specimen, collected by Frebold and illustrated by Tozer (1965a) is in the Geological Survey of Canada and a plastotype in the Museum of Comparative Zoology. The Ellesmere Island and British Columbia species are in the Geological Survey of Canada.

Keyserlingites middendorffi (Keyserling)

Ceratites middendorffi Keyserling, 1845: 170, pl. 1, fig. 1; pl. 2, figs. 1, 3 (non 2, 4); Mojsisovics, 1882: 11; Mojsisovics, 1885: 153, pl. 6, fig. 2; Mojsisovics, 1886: 38, pl. 2, figs. 12, 13, pl. 3, figs. 1a-c, pl. 20, fig. 10; Frech, 1905: 200; Spath, 1934: 359.

Ammonites middendorffi,—v. Buch, 1848: 15.

Ceratites (*Stephanites*) *middendorffi*,—Frech, 1905: pl. 28, fig. 7.

Keyserlingites middendorffi,—Diener, 1907: 44; Diener, 1915: 178; Spath, 1934: 33, 353, 355, 356, 363, 432, fig. 119d; Kummel, 1961: 521; Popov, 1961: 54, pl. 15, figs. 2, 3.

Ceratites nikitini Mojsisovics, 1888: 6, pl. 1, figs. 12, 13.

Keyserlingites nikitini,—Diener, 1915: 179; Popov, 1961: 56, pl. 15, fig. 4.

Ceratites schrenki Mojsisovics, 1886: 47, pl. 4, fig. 1.

Keyserlingites schrenki,—Diener, 1915: 179.

Of the two species of Siberian keyserlingitids this is the compressed form. It differs from *subrobustus* also in ornamentation, with its prominent nodes just below the umbilical shoulder and only weak ridges crossing the venter. *Keyserlingites nikitini* (Mojsisovics) is much like *middendorffi* except for being more evolute. That species is known from only three speci-

mens and the difference in involution of the conch from *middendorffi* is a little less than 10 percent. As these two "species" are associated in the same beds, I feel it more likely that *nikitini* is nothing more than an evolute variant of *middendorffi*. In the same vein one can look upon *Keyserlingites schrenki* (Mojsisovics) as an involute variant of *middendorffi*. In its compressed whorls *K. middendorffi* is similar to *K. bearriverensis* n. sp. from southeast Idaho, but the two species differ significantly in their ornament pattern.

The sutures of these species are illustrated on Figure 38.

Occurrence. This species is only known from northern Siberia where it occurs in the *Olenekites* Zone at the mouths of the Lena and Olenek rivers, in the Kolyma River basin of the Verkhoyan region, and in eastern Taymyr.

Repository. The Siberian specimens are in the Central Geological Museum, Leningrad. The Museum of Comparative Zoology has a specimen from the delta region of the Lena River (MCZ 6108).

Keyserlingites bearlakensis n. sp.

Plate 37, figures 5, 6; Plate 38, figures 1-3; Text-figure 38

Keyserlingites n. sp. cf. *K. subrobustus* (Mojsisovics),—Kummel, 1954: 187.

The largest ammonoids in the upper member of the Thaynes Formation at Hammond Creek, Bear River Range, southeast Idaho, are species of *Keyserlingites*. This species is represented by ten, mainly fragmentary, specimens. The conch is evolute with an umbilicus measuring approximately 30 percent of the diameter. The whorls are depressed, being wider than high, with a broadly arched venter. The lateral areas are likewise convex and merge onto a broadly rounded umbilical slope. The conch is ornamented with large, prominent bullae on the lateral areas. On the holotype (Pl. 38, figs. 1, 2), there are nine bullae on the half volution. The bullae

occupy the entire lateral area. Between the bullae there may or may not be low, weak ribs extending across the venter from one ventral shoulder to the other. The suture is shown on Figures 38G-I.

The collections contain one small specimen of 7.8 mm in diameter, which is believed to be the juvenile whorls of this species (Pl. 37, figs. 5, 6). What is of special interest in this specimen is that at this diameter it already has all of the main morphological features of the large adult specimens. This includes the depressed whorl section, bullae, and suture (Fig. 38I).

The Tobin Formation of the Tobin Range, Nevada, has yielded a few poorly preserved, fragmentary specimens that are possibly conspecific with this species. In its depressed whorls this species is much like the Arctic *K. subrobustus* but differs in ornament pattern.

Occurrence. Upper member of Thaynes Formation, Hammond Creek, Bear River Range, southeast Idaho.

Repository. Holotype MCZ 9561 (Pl. 38, figs. 1, 2); figured paratypes MCZ 9517 (Pl. 38, fig. 3), MCZ 9518 (Pl. 37, figs. 5, 6); unfigured paratypes MCZ 9519.

Keyserlingites bearriverensis n. sp.

Plate 37, figures 1-4; Text-figure 38

It was pointed out above that of the two Siberian species of *Keyserlingites*, one was a form with a depressed whorl section (*K. subrobustus*) and the other was a form with a compressed whorl section (*K. middendorffi*). A similar relationship exists with two species of *Keyserlingites* that occur in the upper member of the Thaynes Formation at Hammond Creek, Bear River Range, southeast Idaho. Of the compressed species the collections contain eight poorly preserved specimens.

The venter is highly arched, grading onto convex lateral areas; the umbilical shoulder and wall are broadly convex. Prominent bullae on the lateral areas extend from the

umbilical shoulder to the ventral shoulder; they are essentially radial on the phragmocone but on the living chamber become slightly prosiradiate. The suture is shown on Figure 38E, F.

The collection contains a small specimen of 9.8 mm in diameter which is believed to be a juvenile of this species. Like the juvenile specimen of *K. bearriverensis* described above, this specimen already has the essential features of the adult. That is, the compressed whorl section, high, arched venter, and bullae are clearly developed. The suture has the basic pattern of lobes and saddles, but the lobes are only slightly denticulated (Fig. 38F).

In the compressed nature of the conch this species is similar to *K. middendorffi*. It differs from that species in the nature of the bullae and of the venter.

The fact that each of the Siberian and Idaho late Scythian faunas have two species, one compressed in whorl section, the other depressed, tempts one to consider the possibility that these are dimorphs of one species in each case. However, the material available from each fauna is far too limited to explore this problem further.

Occurrence. Upper member of the Thaynes Formation, Hammond Creek, Bear River Range, southeast Idaho.

Repository. Holotype MCZ 9520 (Pl. 37, figs. 1, 2); figured paratype MCZ 9521 (Pl. 37, figs. 3, 4); unfigured paratypes MCZ 9522.

Keyserlingites stephensoni n. sp.

Plate 46, figure 1; Text-figure 38

This species is based on the largest specimen of an ammonite discovered in the Lower Triassic formations of western United States. It was discovered by Gordon R. Stephenson of the U.S. Agricultural Research Service of Boise, Idaho, in whose honor the species is named. The specimen measures 268.0 mm in diameter, 106 mm for the height of the last whorl, and 80 mm for the diameter of the umbilicus. The

specimen was broken out of a large black limestone concretion, and one side is embedded in matrix. Even though a width measurement is not possible, it is clear that the whorls are higher than wide. The lateral areas are broadly convex, and slightly convergent; the venter is broadly arched. Both the ventral and umbilical shoulders are rounded.

The most striking feature of the specimen is its ornamentation. On the umbilical shoulder are large nodes. On the last volution there are seven such nodes that adorally increase in size. On the ventral shoulder there are slightly elongated nodes (clavi) which also increase in size adorally. There are approximately twice as many nodes on the ventral shoulder as on the umbilical shoulder.

The shell is preserved over much of one side of the specimen. The shell in the region of the nodes measures as much as 5 mm in thickness. On the mid-part of the venter the shell is only 2 mm thick.

The suture is only partially known, that is, the first lateral lobe, second lateral saddle, and the second lateral lobe are visible (Fig. 38J). This species is remarkably similar in its gross feature to the specimen of *Keyserlingites middendorffi* figured by Mojsisovics (1886: pl. 3) from the Olenek fauna of northern Siberia. The Idaho specimen lacks the transverse ventral ribs, and has more prominent nodes on the ventral shoulder. It differs from *Keyserlingites subrobustus*, also from the Olenek fauna, and from *Keyserlingites bearlakensis* in its compressed rather than depressed whorl section.

Occurrence. From the lower black limestone member of the Thaynes Formation, Fort Hall Indian Reservation, southeast Idaho. The specimen is presumably from a horizon equivalent to the *Columbites* fauna of the Bear Lake region.

Repository. This specimen has been presented by Mr. G. R. Stephenson to the Department of Geology, Washington State University, Pullman, Washington.

Keyserlingites sp. indet. (Afghanistan)

Keyserlingites sp. indet. Kummel, 1968b: 500, pl. 1, figs. 5-7.

A small specimen, 22 mm in diameter, is the first record of the genus *Keyserlingites* in late Scythian strata of Tethys. The specimen appears to be all phragmocone and has a whorl height of 9 mm and an umbilical diameter of 7.5 mm. The whorl sides are slightly convex and converge toward a broadly rounded venter. The umbilical shoulder is abruptly rounded and the umbilical wall nearly vertical. There are large nodes, one approximately every quarter volution, that are anchored on the umbilical shoulder and extend upward on the flanks. The most adoral node, at a diameter of 21 mm, extends half way across the lateral areas. The suture consists of a simple pronged ventral lobe, a large first lateral saddle and first lateral lobe, and much smaller second lateral saddle and lobe; a low denticulated auxiliary lobe occupies the umbilical wall. The general shape of the conch, the nodes, and the suture identifies this specimen as *Keyserlingites*. The specimen is most probably a juvenile form.

Occurrence. *Subcolumbites* fauna, Kotal-e-Tera, Afghanistan.

Repository. MCZ 10139.

Genus *Olenekites* Hyatt, 1900

Type species, *Dinarites spiniplicatus* Mojsisovics, 1886

Olenekites spiniplicatus (Mojsisovics)

Dinarites spiniplicatus Mojsisovics, 1886: 10, pl. 1, figs. 1-5, 8-16, 18-26, pl. 2, figs. 1-5, 7; Mojsisovics, 1888: 2, pl. 1, figs. 1-3; Frech, 1905: pl. 28, fig. 9.

Olenekites spiniplicatus,—Hyatt, 1900: 559; Spath 1934: 361, pl. 7, fig. 3; Kiparisova, 1947: 166; Kummel, in Arkell et al., 1957: 1146, figs. 178, 5; Popov, 1961: 34, pl. 14, figs. 3, 4; Vozin and Tikhomirova, 1964: 67, figs. 4-7.

Dinarites (Olenekites) spiniplicatus,—Diener, 1915: 123.

Dinarites volutus Mojsisovics, 1886: 14, pl. 1, fig. 6, pl. 2, fig. 6; Mojsisovics, 1888: 4, pl. 1, figs. 5, 6.

Dinarites (Olenekites) volutus,—Diener, 1915: 124.

- Dinarites densiplicatus* Mojsisovics, 1886: 15, pl. 1, fig. 7; Mojsisovics, 1888: 4, pl. 1, fig. 4.
Dinarites (*Olenekites*) *densiplicatus*,—Diener, 1915: 123.
Dinarites altus Mojsisovics, 1886: 16, pl. 2, fig. 8.
Dinarites (*Olenekites*) *altus*,—Diener, 1915: 123.
Olenekites altus,—Popov, 1961: 35, pl. 13, fig. 1b; Vozin and Tikhomirova, 1964: 68, pl. 33, fig. 3.
Dinarites intermedius Mojsisovics, 1886: 17, pl. 2, fig. 9.
Dinarites (*Olenekites*) *intermedius*,—Diener, 1915: 123.
Dinarites glacialis Mojsisovics, 1886: 18, pl. 2, fig. 11.
Dinarites (*Olenekites*) *glacialis*,—Diener, 1915: 123.
Olenekites glacialis,—Popov, 1961: 34, pl. 13, fig. 16.

Both Mojsisovics (1886) and Spath (1934) have made particular note of the large degree of variation in nearly all morphological features in this species. Mojsisovics had 64 specimens of *spiniplicatus*, but for the remaining five species he assigned to his *Dinarites* he had only one, two, or three specimens per species. Restudy of the type specimens, topotype material, and the literature of Mojsisovics (1886, 1888) and Popov (1961) demonstrate clearly that there is but one species of *Olenekites* in this north Siberian region.

Occurrence. Northern Siberia, mainly at and around mouth of Olenek River.

Repository. The Museum of Comparative Zoology contains a number of topotype specimens (MCZ 8682, 8683). The Central Geological Museum, Leningrad, contains the types of Mojsisovics and Popov.

Olenekites mangyshlakensis Astakhova

Olenekites mangyshlakensis Astakhova, 1960a: 148, pl. 34, figs. 6, 7, text-fig. 14.

This species is obviously quite close to *O. spiniplicatus* and could possibly be conspecific. However, since data available on this species are so incomplete, it seems best to accept it as a separate and distinct species.

Occurrence. Mangyshlak Peninsula, Karatauchik Range, from *Columbites* Zone of

Astakhova, 600–650 m above base of Tyur-Upa suite.

Olenekites canadensis Tozer

Olenekites canadensis Tozer, 1961a: 73, pl. 18, figs. 1–3; Tozer, 1965a: 32, pl. 4, figs. 1–8, text-fig. 10.

This is likewise a highly variable species, differing from *O. spiniplicatus* mainly in its truncate venter.

Occurrence. Blaa Mountain Formation, upper Scythian, Ellesmere Island.

Olenekites cf. *spiniplicatus* (Mojsisovics) Plate 36, figures 4–6

Previously, the two available specimens of this species were assigned to *Olenekites*, with question, as no suture is preserved (Kummel, 1954). In recent years, I have had the opportunity of examining numerous specimens of *Olenekites* from the type locality at the mouth of the Olenek River, northern USSR, and no longer have any doubt but that these specimens represent a species of *Olenekites*. Each specimen consists of only one-half volution. The whorls are approximately as high as wide; the venter is broadly rounded, as are the ventral shoulders. The umbilical shoulders are more abruptly rounded, and the umbilical wall nearly vertical. The lateral area bears bullae that begin on the umbilical shoulder and decrease gradually toward the ventral shoulder. On one specimen (Pl. 36, figs. 4, 5) the bullae are rather robust and widely spaced, there being approximately four per half volution. On the other specimen the bullae are narrower, not as robust, and there are approximately six bullae per half volution. Both Mojsisovics (1886) and Spath (1934) have emphasized the exceedingly variable character of this species. The two specimens recorded here can be compared favorably with one or more of the specimens illustrated by Mojsisovics (1886: pl. 1). The species *O. canadensis*, described by Tozer (1961a: 73) from Ellesmere Island, is also closely

related to *Olenekites spiniplicatus*, differing mainly in the subtabulate character of the venter on the later whorls.

Occurrence. Uppermost member of Thaynes Formation, Hammond Creek, Bear River Range, southeast Idaho.

Repository. MCZ 9482 (Pl. 36, figs. 3, 4), MCZ 9476 (Pl. 36, figs. 5, 6).

Genus *Eukashmirites* n. gen.

Type species, *Kashmirites acutangulatus* Welter, 1922: 125, pl. 9, figs. 9–12

The genus *Kashmirites* was introduced by Diener (1913: 33) for the "group of *Celtites subrectangularis* Waagen or *Celtites armatus* Waagen from the Ceratite Formation of the Salt Range." Diener at that time was dealing with a Scythian fauna from Kashmir. He had within his Kashmir fauna fragmentary specimens which he felt belonged to the *Celtites* of Waagen described from the Salt Range. This new generic name was introduced for these Salt Range and Himalayan species as they no longer could be accommodated in the genus *Celtites* as redefined by Mojsisovics (1893). In this revision it is quite apparent that Diener overlooked the genus *Pseudoceltites* Hyatt (1900)—type species *Celtites multiplicatus* Waagen. In the discussion of the genus *Pseudoceltites* it has already been pointed out that *Celtites armatus* (the type of *Kashmirites*, so designated by Diener, 1915: 137) is a synonym of *Celtites multiplicatus*. There is still, however, a need for separation of the group of ammonoids with subquadrate whorl sections, lateral ribs, occasional nodes which cross the venter, and a simple two lobed suture. Both Diener (1913) and Spath (1934) looked upon *Kashmirites blaschkei* Diener as a typical species. As noted by Diener (1913), the Kashmir specimens of *blaschkei* and related species are poorly preserved and fragmentary. Because of this I select Welter's Timor species *acutangulatus* as the type species of this new genus.

Eukashmirites is fairly well represented

in the mid-Scythian zones of the Himalayas and Timor. In the late Scythian *Prohumerites* Zone it is represented by only two species, both from the Mangyshlak Peninsula in southern U.S.S.R.

Eukashmirites subdimorphus (Kiparisova)

Kashmirites subdimorphus Kiparisova, 1947: 148, pl. 33, figs. 3–5, text-figs. 40, 41; Astakhova, 1960a: 140.

The overall shell morphology of this species is very much like that of the type species—*E. acutangulatus*—from Timor except the whorls tend to be broader on the adoral volutions. The other species of this genus, *E. contortus* Astakhova, also known only from the Mangyshlak Peninsula, is a much more compressed form with slightly sinuous ribs on the adoral whorls.

Occurrence.—Scythian formation of Mangyshlak Peninsula but Kiparisova (1947) gives no precise horizon. Astakhova (1960b: 150) lists the species from her *Tirolites* Zone.

Eukashmirites contortus (Astakhova)

Kashmirites contortus Astakhova, 1960a: 139, pl. 33, fig. 5, text-fig. 7.

This species is also quite similar to the type species—*acutangulatus*—but much more compressed in its whorl section; the lateral ribs also are sinuous on the adoral whorls. The sample of this species available to Astakhova and to Kiparisova when she described *E. subdimorphus* was very small. It is conceivable that a large sample would show these two species to be synonyms.

Occurrence. *Tirolites* Zone of Astakhova, Mangyshlak Peninsula.

Genus *Anakashmirites* Spath, 1930

Type species, *Danubites nivalis* Diener, 1897

Species of this genus are known mainly from the mid-Scythian *Owenites* Zone. The only records of this genus are fragmentary and specifically indeterminate forms from the Narmia Member of the Mianwali Formation in the Surghar Range of West

Pakistan (Kummel, 1966). These specimens in conch form and ornamentation are very much like the species from the *Owenites* Zone but the suture is distinctly more advanced.

Superfamily CERATITACEAE Mojsisovics, 1879

Family TIROLITIDAE Mojsisovics, 1882

Genus *Tirolites* Mojsisovics, 1879

Type species, *Tirolites idrianus* Hauer, 1865

As with most genera of ornamented ammonites, the genus *Tirolites* includes a more than generous number of species. The great majority of these species were established for forms from the Werfen Formation of the Alps and Dalmatia. Mojsisovics in his classic monograph on "Die Cephalopoden der mediterranen Triasprovinz" (1882) recognized 14 species of *Tirolites*. The ammonites of the Werfen Formation were monographed by Kittl (1903), who recognized 40 species of *Tirolites* and three subgenera! Most subsequent authors (e.g. Smith, 1932; Spath, 1934) recognized that many (or most) of Kittl's species were very closely allied or identical, yet continued to recognize all the species—I presume as a matter of convenience.

I have had the opportunity of studying the Werfen Formation collection described by Kittl (1903), in the Natural History Museum, Vienna. All the specimens figured by Kittl (1903) were photographed, and measurements were made of all specimens sufficiently well preserved. It should be remarked here that Kittl's monograph is profusely illustrated by line drawings, and that in effect Kittl illustrated nearly every specimen of fair to good preservation. Most of the unfigured paratypes and topotypes are very poorly preserved specimens. No satisfactory photographic illustrations of the Werfen Formation *Tirolites* exist; for this reason the more important types of Kittl's study are reproduced here. Study of these illustrations first of all clearly shows the relatively poor preservation of

most of the specimens, particularly since these figured forms are the very best specimens in the collection.

Tubercles on the ventro-lateral shoulder form the basic ornamentation pattern for *Tirolites*. Very often there are radial or prosiradiate ribs that extend from the tubercles dorsally along the flanks for variable distances. Study of the hundreds of specimens in the Kittl collection soon gives one the impression that they represent one continuous gradational series. Mojsisovics (1882) recognized two primary groups within the genus *Tirolites*, the *Spinosi* with ornamented inner whorls and the *Seminudi* with smooth inner whorls. Of the 14 species of *Tirolites* that Mojsisovics (1882) recognized from the Werfen Formation, 7 were assigned to the *Spinosi*, and 7 to the *Seminudi*. Kittl (1903) adopted the same two groups and recognized three additional groups as subgenera (*Hololobus*, *Svilajites*, *Bittnerites*).

Preservation of the Werfen Formation ammonites is such that retention and exposure of the inner whorls is not the usual thing. There are likewise numerous transitions between the two groups, *Spinosi* and *Seminudi*, and between these and other genera. One is tempted to consider all of the tirolitids of the Werfen Formation as a complex, variable, single species group. This could very well be the case. At the same time, in a general way, the *Seminudi* seldom have ribs associated with the tubercles as do the *Spinosi*. Clearly as a matter of convenience and not because of any real understanding of the relationships, I recognize two major species of tirolitids from the Werfen Formation—*T. idrianus* (*Seminudi*) and *T. cassianus* (*Spinosi*).

The type specimen of *Tirolites* (*Svilajites*) *cingulatus* is poorly preserved. Spath (1934) raised this group to generic rank and this was accepted by Kummel (in Arkell, et al., 1957). Examination of the type specimen leads me to believe that at best this can be recognized only as a distinct species of *Tirolites*.

Tirolitoides prior (Kittl, 1903) was said to have umbilical nodes and a more ceratitic suture. The so-called umbilical nodes are no more than a reflection of poor preservation and the suture is no different from that of many other specimens figured by Kittl (1903).

The comprehensive interpretation of the Werfen Formation tirolitids creates special problems in assessing the relationships to species from other horizons and localities. In no other locality or formation are the tirolitids as abundantly represented as they are in the Werfen Formation. The other species of *Tirolites* recognized here are discussed below, but in almost every case the species is known from very few specimens.

The *Subcolumbites* fauna of Albania has yielded three specimens of *Tirolites* (Arthaber, 1908, 1911) which are here considered to be *T. idrianus*. The upper Scythian formation of the Mangyshlak Peninsula has yielded *T. rossicus* Kiparisova (1947) and *T. impolitus* Astakhova (1960a). These two species were said to be associated with *T. cassianus* and *T. spinosus*. The Narmia Member of the Mianwali Formation in the Salt Range of West Pakistan has yielded a single indeterminate species of *Tirolites* (Kummel, 1966). The *Hedenstroemia* fauna of the Himalayas has yielded a single species—*T. injucundus* Krafft and Diener (1909). This is the oldest species of the genus recorded to date. A fragmentary specimen presumably from a *Subcolumbites* horizon in Kwangsi was assigned by Chao (1959) to *Tirolites* cf. *darwini*. Tirolitids are present in strata of Olenek age in the basin of the Kolyma River, Siberia (Popov, 1961).

Finally, in western North America there are several records of *Tirolites*. In fact the stratigraphic position of the *Tirolites* fauna as generally interpreted was established on the basis of the sequence of faunal zones in southeastern Idaho. In Paris Canyon, Smith (1932) discovered a small, poorly preserved fauna including three species of

Tirolites, above his *Meekoceras* Zone and below his *Columbites* Zone. I have had several occasions to verify this sequence. These Paris Canyon species are very similar to the *Spinosi* of the Werfen Formation and are treated here as a single but distinct species—*T. harti* Smith. From the overlying *Columbites* Zone, Smith (1932) described a specimen as *T. illyricus*. Additional specimens of this species suggest its separation as a distinct form. The *Columbites* fauna contains two other species of *Tirolites* very different from the form Smith (1932) assigned to *T. illyricus*. Silberling (in Hose and Repenning, 1959: 2194) has recorded indeterminate species from the upper part of the Thaynes Formation in the Confusion Range of western Utah. These are recorded here as *T. cf. cassianus*.

It can be seen from this brief summary that species of *Tirolites* are now recognized throughout the upper half of the Scythian.

Tirolites idrianus (Hauer)

Plate 18, figures 1–6; Plate 66, figures 1–13; Plate 67, figures 1–9; Plate 68, figures 1–9; Plate 69, figures 1–10; Text-figure 39

Ceratites idrianus Hauer, 1865: 610, pl. 1, figs. 4, 5.

Tirolites idrianus.—Mojsisovics, 1879: 138; Mojsisovics, 1882: 67, pl. 1, fig. 1; Kittl, 1903: 36, pl. 5, figs. 8, 9; Arthaber, in Frech, 1906: pl. 34, fig. 14.

Tirolites seminudus Mojsisovics, 1882: 66, pl. 2, fig. 11; Kittl, 1903: 40, pl. 6, figs. 3–10, 17, 18; Arthaber, 1908: 275, pl. 11(1), fig. 9; Diener, 1915: 279; Spath, 1934: 375.

Tirolites seminudus var. *nudior* Kittl, 1903: 41, pl. 6, fig. 3; Spath, 1934: 375.

Tirolites seminudus var. *plicosus* Kittl, 1903: 41, pl. 6, figs. 5, 7; Diener, 1915: 279; Spath, 1934: 375.

Tirolites mercurii Mojsisovics, 1882: 68, pl. 1, fig. 9; Kittl, 1903: 38, pl. 5, figs. 10, 11, pl. 6, figs. 1, 2; Diener, 1915: 278; Spath, 1934: 377.

Tirolites paucispinatus Kittl, 1903: 39, pl. 6, fig. 11, pl. 7, figs. 4–6; Diener, 1915: 279.

Tirolites distans Kittl, 1903: 42, pl. 6, figs. 12–16, pl. 7, figs. 7, 8; Diener, 1915: 278; Spath, 1934: 375.

Tirolites quenstedti Mojsisovics, 1882: 66, pl. 2,

- fig. 12; Kittl, 1903: 42, pl. 6, figs. 19, 20; Diener, 1915: 279.
- Tirolites robustus* Kittl, 1903: 43, pl. 7, figs. 9–11, pl. 8, fig. 1; Diener, 1915: 279; Spath, 1934: 377.
- Tirolites dimidiatus* Kittl, 1903: 44, pl. 8, fig. 15; Diener, 1915: 278; Spath, 1934: 377.
- Tirolites stachei* Kittl, 1903: 45, pl. 7, fig. 14; Diener, 1915: 280; Spath, 1934: 377.
- Tirolites dinarus* Mojsisovics, 1882: 74, pl. 2, fig. 9; Kittl, 1903: 45.
- Tirolites hybridus* Kittl, 1903: 46, pl. 8, fig. 2; Diener, 1915: 278.
- Tirolites angustus* Kittl, 1903: 47, pl. 7, fig. 12; Diener, 1915: 277; Spath, 1934: 377.
- Tirolites subillyricus* Kittl, 1903: 47, pl. 7, figs. 15, 16; Diener, 1915: 280.
- Tirolites illyricus* Mojsisovics, 1882: 68, pl. 2, fig. 10; Kittl, 1903: 48, pl. 8, figs. 3, 4, 6–9; Arthaber, 1911: 250, pl. 22(6), fig. 4; Diener, 1915: 278; Spath, 1934: 373.
- Tirolites repulsus* Kittl, 1903: 49, pl. 8, figs. 5, 10, 11, 14; Diener, 1915: 279.
- Tirolites rotiformis* Kittl, 1903: 50, pl. 8, figs. 12, 13; Diener, 1915: 279.
- Tirolites rectangularis* Mojsisovics, 1882: 69, pl. 3, fig. 5; Kittl, 1903: 50, pl. 8, figs. 16, 17; Arthaber, 1911: 251, pl. 22(6), fig. 5; Diener, 1915: 279; Spath, 1934: 374.
- Tirolites undulatus* Kittl, 1903: 52, pl. 7, fig. 13; Diener, 1915: 280.
- Tirolites heterophanus* Kittl, 1903: 38, pl. 5, fig. 7.

The species *idrianus* includes all the "species" that had been included by Mojsisovics and Kittl in the *Seminudi*. Measurements of 122 specimens from the Werfen Formation of Muć, studied by Kittl, are given on Table 44 and plotted on Figure 39. There is clearly considerable variation in these conch parameters. The same is true of the pattern of ornamentation, the principal criterion used to differentiate species within this group. The illustrations given here should amply show that the number, spacing, etc., of the tubercles are highly variable. The sutures in the *Seminudi* were claimed to be entire, that is, goniatic. This is not at all certain, as details of fine denticulations are most often not retained in the kind of preservation which characterizes the Werfen Formation fauna. The position of the lateral lobe is likewise highly variable.

Occurrence. Werfen Formation of Alps, Dalmatia, and associated regions. The

three specimens of *Tirolites* recorded by Arthaber (1908, 1911) from the *Subcolumbites* fauna of Albania are included in this species.

Repository. All of the Kittl collection is in the Natural History Museum, Vienna. The specimens from the *Subcolumbites* fauna of Albania are in the Paleontological Institute, Vienna.

Tirolites cassianus (Quenstedt)

Plate 63, figures 1–9; Plate 64, figures 1–4; Plate 65, figures 1–9; Plate 70, figures 3–6, 11, 12; Text-figures 40, 41

- Ceratites cassianus* Quenstedt, 1849: 231, pl. 18, fig. 11; Hauer, 1865: 606, pl. 2, figs. 1, 2; Laube, 1869: 61, pl. 37, fig. 1.
- Ammonites* (*Ceratites*) *cassianus*,—Hauer, 1851: 6, pl. 2, fig. 5.
- Tirolites cassianus*,—Mojsisovics, 1882: 70, pl. 2, fig. 48, pl. 81, fig. 3; Tommasi, 1895: 69, pl. 4, fig. 15; Kittl, 1903: 54, pl. 9, figs. 4–6; Arthaber, 1906: pl. 34, fig. 15; Wittenburg, 1908: 285, pl. 40(5), fig. 19; Diener, 1915: 278; Diener, 1925: 80, pl. 12, fig. 1; Ogilvie-Gordon, 1927: 31, pl. 3, fig. 39; Kutassy, 1933: 674; Spath, 1934: 369, fig. 126; Leonardí, 1935: 90, pl. 6, figs. 5, 6; Kollárová-Andrusovová, 1961: 56, pl. 1, figs. 1, 3, 4.
- Tirolites cassianus* var. *tenuis* Mojsisovics, 1882: 71, pl. 2, figs. 4–6; Kittl, 1903: 55.
- Tirolites cassianus* var. *alpha* Kittl, 1903: 55, pl. 9, figs. 4, 5.
- Tirolites angustilobatus* Kittl, 1903: 54, pl. 9, figs. 1–3; Diener, 1915: 277; Spath, 1934: 370.
- Tirolites angustilobatus* var. *alpha* Kittl, 1903: 54, pl. 8, fig. 19.
- Tirolites spinosus* Mojsisovics, 1882: 70, pl. 1, fig. 10, pl. 2, figs. 1–3; Tommasi, 1895: 70, pl. 4, fig. 16; Kittl, 1903: 56, pl. 9, fig. 7; Diener, 1915: 279; Spath, 1934: 370; Leonardí, 1935: 91, pl. 6, figs. 7–9; Kollárová-Andrusovová, 1961: 57, pl. 1, figs. 2a, b.
- Tirolites haueri* Mojsisovics, 1882: 71, pl. 3, figs. 2–4; Kittl, 1903: 56, pl. 9, figs. 8–13; Diener, 1915: 278; Spath, 1934: 371.
- Tirolites haueri* var. *minor* Kittl, 1903: 58, pl. 10, figs. 1–3; Diener, 1915: 278.
- Tirolites multispinatus* Kittl, 1903: 58, pl. 11, fig. 9; Diener, 1915: 279.
- Tirolites percostatus* Kittl, 1903: 58, pl. 10, fig. 6; Diener, 1915: 279.
- Tirolites turgidus* Mojsisovics, 1882: 72, pl. 3, figs. 6, 7; Kittl, 1903: 59, pl. 10, figs. 7, 8; Diener, 1915: 280; Spath, 1934: 371.
- Tirolites darwini* Mojsisovics, 1882: 73, pl. 2,

TABLE 44. MEASUREMENTS OF SPECIMENS OF *TIROLITES IDRIANUS* (HAUER) FROM MUĆ IN DALMATIA STUDIED BY ERNST KITTL, 1903. ALL SPECIMENS ARE DEPOSITED IN THE NATURAL HISTORY MUSEUM, VIENNA.

	D	W	H	U	W/D	H/D	U/D		D	W	H	U	W/D	H/D	U/D
1.	66.0?	18.3	19.0	22.1	27.7?	28.8?	33.5?	25.	44.9	12.8	15.5	17.7	28.5	34.5	39.4
2.	57.3	?	22.7	19.0	?	39.6	33.2	26.	44.7	12.4	18.0	16.0	27.7	40.3	35.8
3.	55.5	18.5	19.9	22.7	33.3	35.9	40.9	27.	44.5	14.4	16.0	16.3	32.4	36.0	36.6
4.	53.7	17.8	18.8?	19.7?	33.1	35.0?	36.7?	28.	44.5	13.2	16.4	16.9	29.7	36.9	38.0
5.	52.6	?	20.7	19.3	?	39.4	36.7	29.	44.5	?	18.4	15.4	?	41.3	34.6
6.	52.5?	16.1	20.0	20.7	30.7?	38.1?	39.4	30.	44.4	?	15.3	17.8	?	34.5	40.1
7.	52.4	13.1	19.9	20.0	25.0	38.0	38.2	31.	44.3	12.1	16.7	19.4	27.3	37.7	43.8
8.	51.8	16.7	18.5	21.1	32.2	35.7	40.7	32.	44.2	13.0	17.3	16.0	29.4	39.1	36.2
9.	51.7	15.5	17.0	21.0?	30.0	32.9	40.6?	33.	44.1	12.3	16.2	17.5?	27.9	36.7	39.7?
10.	51.3	17.1	19.2	18.6	33.3	37.4	36.2	34.	44.1	10.4	9.2	19.1	23.6	20.9	43.3
11.	51.2	14.7	17.4	22.0	28.7	34.0	43.0	35.	43.7	12.6	15.2	17.3	28.8	34.8	39.6
12.	51.1	16.2	20.3	18.7?	31.7	39.7	36.6?	36.	43.4	10.1	15.7	17.0	23.3	36.2	39.2
13.	50.2	10.0±	18.5	19.0	19.9±	36.9	37.8	37.	43.3	14.3	16.8	16.6	33.0	38.8	38.3
14.	50.0	12.0	16.5	19.6	24.0	33.0	39.2	38.	43.3	10.0	14.5	18.3	23.1	33.5	42.3
15.	49.7	9.9	17.3	21.1	19.9	34.8	42.5	39.	43.2	14.0	17.3	15.4	32.4	40.0	35.6
16.	49.6	15.8	17.8	19.8	38.9	35.9	39.9	40.	43.2	11.2	12.8	21.8	25.9	29.6	50.5
17.	48.4	13.2	18.0	18.1	27.3	37.2	37.4	41.	43.2	8.5?	16.7	15.7	19.7?	38.7	36.3
18.	47.5	14.3	16.0	17.5?	30.1	33.7	36.8	42.	43.0	10.4?	16.8	15.7	24.2	39.1	36.5
19.	47.2	10.8	17.2	18.4	22.9	36.4	39.0	43.	43.0	?	17.1	15.2	?	39.8	35.3
20.	47.2	?	19.2	17.1	?	40.7	36.2	44.	42.7	14.1	15.8	16.2	33.0	37.0	37.9
21.	46.3	15.5?	17.3	17.7	33.5?	37.4	38.2	45.	42.7	13.3	15.7	16.0	31.1	36.8	37.5
22.	46.2	15.0	17.2	17.5	32.5	37.2	37.9	46.	42.6	13.7	15.3	17.0	32.2	35.9	39.9
23.	45.3	16.6	16.7	16.8?	36.6	36.9	37.1?	47.	42.6	13.1	14.7	16.0	30.8	34.5	37.6
24.	45.0	13.9	16.8	18.4	30.9	37.3	40.9	48.	42.4	13.4	14.6	17.7	31.6	34.4	41.7

1. Lectotype, *T. undulatus* Kittl (1903: pl. 7, fig. 13).
2. Lectotype, *T. stachei* Kittl (1903: pl. 7, fig. 14).
3. Plesiotype, *T. mercurii*,—Kittl (1903: pl. 6, fig. 2).
4. Unfigured paratype, *T. hybridus* Kittl (1903: 46).
5. Lectotype, *T. hybridus* Kittl (1903: pl. 8, fig. 2).
- 6, 16, 37, 45, 46, 48, 50, 64, 92. Unfigured paratypes, *T. robustus* Kittl (1903: 43).
- 7, 10, 12, 39, 63, 74, 86, 88. Unfigured paratypes, *T. angustus* Kittl (1903: 47).
- 8, 18, 75, 77, 85, 99, 102. Unfigured paratypes, *T. mercurii*,—Kittl (1903: 38).
9. Plesiotype, *T. mercurii*,—Kittl (1903: pl. 6, fig. 1).
- 11, 55, 61, 67, 70, 71, 76, 89, 90, 95, 103, 104, 105, 106, 110, 111, 115, 118, 121, 122. Unfigured specimens, *T. seminudus*,—Kittl (1903: 40).
13. Plesiotype, *T. quenstedti*,—Kittl (1903: pl. 6, fig. 19).
14. Plesiotype, *T. illyricus*,—Kittl (1903: pl. 8, fig. 4).
15. Plesiotype, *T. seminudus*,—Kittl (1903: pl. 6, fig. 3).
- 17, 87, 98. Unfigured specimens, *T. quenstedti*,—Kittl (1903: 42).
19. Plesiotype, *T. quenstedti*,—Kittl (1903: pl. 6, fig. 20).
20. Paralectotype, *T. distans* Kittl (1903: pl. 7, fig. 8).
21. Plesiotype, *T. mercurii*,—Kittl (1903: pl. 5, fig. 11).
22. Plesiotype, *T. illyricus*,—Kittl (1903: pl. 8, fig. 3).
23. Plesiotype, *T. mercurii*,—Kittl (1903: pl. 5, fig. 10).
24. Paralectotype, *T. distans* Kittl (1903: pl. 6, fig. 12).
25. Syntype, *T. subillyricus* Kittl (1903: pl. 7, fig. 15).
- 26, 30. Unfigured paratypes, *T. subillyricus* Kittl (1903: p. 17).
27. Paralectotype, *T. distans* Kittl (1903: pl. 6, fig. 14).
28. Plesiotype, *T. seminudus*,—Kittl (1903: pl. 6, fig. 4).
- 29, 83, 113. Unfigured paratypes, *T. paucispinus* Kittl (1903: 39).
- 31, 36, 60, 65, 66, 81. Unfigured specimens, *T. illyricus*,—Kittl (1903: 48).
32. Plesiotype, *T. illyricus*,—Kittl (1903: pl. 8, fig. 8).
- 33, 53, 69, 73, 94, 101. Unfigured paratypes, *T. distans* Kittl (1903: 42).
34. Plesiotype, *T. rectangularis*,—Kittl (1903: pl. 8, fig. 16).
35. Plesiotype, *T. seminudus*,—Kittl (1903: pl. 6, fig. 7).
38. Figured type, *T. repulsus* Kittl (1903: pl. 8, fig. 11).
40. Figured type, *T. rotiformis* Kittl (1903: pl. 8, fig. 12).
41. Plesiotype, *T. illyricus*,—Kittl (1903: pl. 8, fig. 7).
42. Plesiotype, *T. seminudus*,—Kittl (1903: pl. 6, fig. 8).
43. Plesiotype, *T. seminudus*,—Kittl (1903: pl. 6, fig. 18).
44. Figured type, *T. repulsus* Kittl (1903: pl. 8, fig. 5).
- 47, 108. Unfigured paratypes, *T. rotiformis* Kittl (1903: 50).

TABLE 44. *Continued.*

	D	W	H	U	W/D	H/D	U/D		D	W	H	U	W/D	H/D	U/D
49.	42.4	12.6	15.1	17.9	29.7	35.6	42.2	86.	38.0	11.7	14.4	14.6	30.8	37.9	38.4
50.	42.3	12.8	17.0	15.3	30.3	40.2	36.2	87.	38.0	8.2?	14.7	14.5?	21.6?	38.7	38.2?
51.	42.3	11.2	15.1	14.8	26.5	35.7	35.0	88.	37.8	8.4?	15.3	13.0	22.2?	40.5	34.4
52.	42.2	14.6	16.2	16.3	34.6	38.4	38.6	89.	37.5	12.0	12.8	15.4	32.0	34.1	41.1
53.	42.1	13.2	14.5	17.1	31.4	34.4	40.6	90.	37.3	10.0	13.3	16.0	26.8	35.7	42.9
54.	42.1	12.0	14.2	17.1	28.5	33.7	40.6	91.	37.0?	11.6	13.8	14.0?	31.4?	37.3?	37.8?
55.	42.0	10.2	15.0	16.1	24.3	35.7	38.3	92.	37.0	11.5	14.5	13.6	31.1	39.2	36.8
56.	41.7	13.8	16.5	14.5	33.1	39.6	34.8	93.	37.0?	11.3	12.6	12.2?	30.5?	34.1?	33.0?
57.	41.5	11.7?	16.1	15.4	28.2?	38.8	37.1	94.	37.0	10.2	13.6	13.3	27.6	36.8	35.9
58.	41.4	15.6	16.8	14.6	37.7	40.6	35.3	95.	36.3	11.5	12.7	14.7	31.7	35.0	40.5
59.	41.4	13.2	15.2	17.0	31.9	36.7	41.1	96.	36.0	8.9	14.0	14.4	24.7	38.9	40.0
60.	41.4	10.5	14.6	17.6	25.4	35.3	42.5	97.	35.7	10.7	12.3	14.8	30.0	34.5	41.5
61.	41.2	12.1?	14.1	16.1	29.4?	34.2	39.1	98.	35.7	9.8	12.0	14.4	27.5	33.6	40.3
62.	41.0	10.8	15.1	17.1	26.3	36.8	41.7	99.	35.6	12.0	14.1	11.7	33.7	39.6	32.9
63.	40.8	13.8	14.7?	15.3?	33.8	36.0?	37.5?	100.	35.6?	11.8	13.0	14.8	33.1?	36.5?	41.6
64.	40.7	13.0	14.0	15.8	31.9	34.4	38.8	101.	35.5	9.4	13.1	14.4	26.5	36.9	40.6
65.	40.5	11.6	9.2	16.1	28.6	22.7	39.8	102.	35.4	10.8?	13.6	14.0	30.5?	38.4	39.5
66.	40.5	11.3	13.8	18.2	27.9	34.1	44.9	103.	35.4	10.5	12.7	12.8	29.7	35.9	36.2
67.	40.5	8.8?	13.5	17.0	21.7	33.3	42.0	104.	35.2	11.3	13.0	13.3	32.1	36.9	37.8
68.	40.1	12.8	14.7	14.6	31.9	36.7	36.4	105.	35.2	9.3	12.6	13.8	26.4	35.8	39.2
69.	40.1	11.9	14.2	16.2	29.7	29.7	40.4	106.	35.0	8.7?	13.1	13.3	24.9?	37.4	38.0
70.	40.1	11.6	13.5	15.5	28.9	33.7	38.7	107.	34.9	8.7?	12.5	13.2	24.9?	35.8	37.8
71.	40.0	12.6	14.2	16.5	31.5	35.5	41.3	108.	34.8	9.5	11.1	15.2	27.3	31.9	43.7
72.	40.0	12.1	15.0	14.3	30.3	37.5	36.8	109.	34.6	10.7	10.5	15.5?	30.9	30.3	44.8?
73.	39.8	11.7	14.1	15.2	29.4	35.4	38.2	110.	34.1	9.6	12.5	13.4	28.2	36.7	39.3
74.	39.7	12.8	15.0	14.4	32.2	37.8	36.3	111.	34.0	10.1	12.6	13.2	29.7	37.1	38.8
75.	39.6	18.8	15.0?	14.5	47.5	37.9	36.6	112.	33.9	9.8	11.8	13.0	28.9	34.8	38.3
76.	39.4	12.3	14.5	15.7	31.2	36.8	39.8	113.	32.3	8.5	11.2	12.7	26.3	34.7	39.3
77.	39.2	14.0	15.0?	14.0?	35.7	38.3?	35.7?	114.	31.8	8.6	11.4	12.8	27.0	35.8	40.3
78.	39.0	13.8	14.1	14.7	35.4	36.2	37.7	115.	31.2	8.8	11.5	11.8	28.2	36.9	37.8
79.	38.8	?	16.1	13.6	?	41.5	35.1	116.	30.8	7.8?	9.6	8.7	25.3?	31.2	28.2
80.	38.6	10.2	13.2	16.2	26.4	34.2	42.0	117.	30.5?	7.5?	11.6	11.4	24.6?	38.0?	37.4?
81.	38.5	9.1	12.5?	17.4	23.6	32.5?	45.2	118.	30.0	7.9	11.2	11.3	26.3	37.3	37.7
82.	38.5	?	16.5	13.7	?	42.9	35.6	119.	28.7	8.9	9.3	12.3	31.0	32.4	42.9
83.	38.2	11.5	13.3	14.6	30.1	34.8	38.2	120.	28.6	7.5	9.0	12.7	26.2	31.5	44.4
84.	38.2	11.4	13.8	14.7	29.8	36.1	38.5	121.	28.4	8.5	11.1	9.9	29.9	39.1	34.9
85.	38.0	13.1	15.3	13.4	34.5	40.3	35.3	122.	21.7	6.3	7.7	7.7	29.0	35.5	35.5

49. Unfigured paratype, *T. rectangularis*,—Kittl (1903: 50).
51. Figured type, *T. paucispinatus* Kittl (1903: pl. 6, fig. 11).
52, 78. Unfigured paratypes, *T. undulatus* Kittl (1903: 52).
54. Figured type, *T. paucispinatus* Kittl (1903: pl. 7, fig. 6).
56. Holotype, *T. angustus* Kittl (1903: pl. 7, fig. 12).
57. Figured type, *T. paucispinatus* Kittl (1903: pl. 7, fig. 4).
58. Lectotype, *T. robustus* Kittl (1903: pl. 7, fig. 9).
59. Plesiotype, *T. rectangularis*,—Kittl (1903: pl. 8, fig. 17).
62. Plesiotype, *T. quenstedti*,—Kittl (1903: pl. 6, fig. 20).
68. Paralectotype, *T. distans* Kittl (1903: pl. 6, fig. 13).
72. Plesiotype, *T. seminudus*,—Kittl (1903: pl. 6, fig. 5).
79. Paralectotype, *T. distans* Kittl (1903: pl. 7, fig. 7).
80. Figured type, *T. repulsus* Kittl (1903: pl. 8, fig. 10).
82. Figured type, *T. paucispinatus* Kittl (1903: pl. 7, fig. 5).
84. Plesiotype, *T. illyricus*,—Kittl (1903: pl. 8, fig. 6).
91. Lectotype, *T. distans* Kittl (1903: pl. 6, fig. 15).
93. Paralectotype, *T. distans* Kittl (1903: pl. 6, fig. 16).
96. Plesiotype, *T. illyricus*,—Kittl (1903: pl. 8, fig. 9).
97, 109, 119. Unfigured paratypes, *T. repulsus* Kittl (1903: 49).
100. Paralectotype, *T. robustus* Kittl (1903: pl. 7, fig. 11).
107. Syntype, *T. subillyricus* Kittl (1903: pl. 7, fig. 16).
112. Plesiotype, *T. seminudus*,—Kittl (1903: pl. 6, fig. 9).
114. Plesiotype, *T. seminudus*,—Kittl (1903: pl. 6, fig. 17).
116. Figured type, *T. rotiformis* Kittl (1903: pl. 8, fig. 13).
117. Plesiotype, *T. seminudus*,—Kittl (1903: pl. 6, fig. 10).
120. Figured type, *T. repulsus* Kittl (1903: pl. 8, fig. 14).

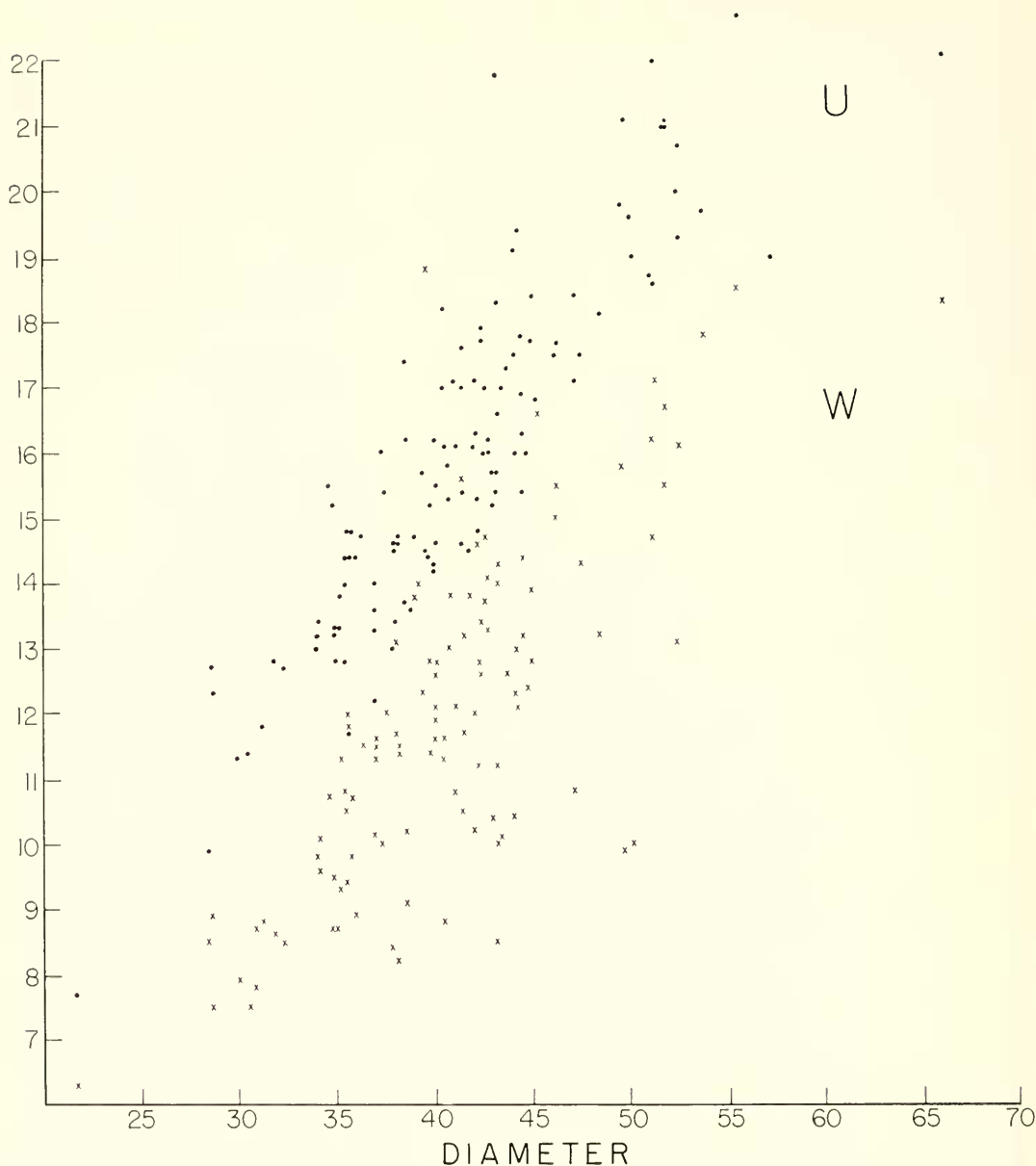


Figure 39. Variation in whorl width (W) and umbilical diameter (U) in *Tiralites idrianus*,—Mojsisovics, from Werfen Formation of Muć, Dalmatia. The data on this graph are from Table 44.

fig. 13, pl. 3, fig. 1; Kittl, 1903: 60, pl. 10, figs. 4, 5, 11, pl. 11, figs. 1–3, 7; Diener, 1915: 278; Patte, 1922: 54, pl. 3, fig. 16; Spath, 1934: 372.

Tirolites darwini var. *cinctus* Kittl, 1903: 61, pl. 10, fig. 4, pl. 11, fig. 3; Spath, 1934: 372.

Tirolites darwini var. *reminiscens* Kittl, 1903: 61, pl. 10, fig. 5; Spath, 1934: 372.

Tirolites darwini var. *modestus* Kittl, 1903: 61, pl. 11, fig. 7; Spath, 1934: 372.

Tirolites darwini var. *costatus* Kittl, 1903: 62, pl. 11, fig. 2; Spath, 1934: 372.

Tirolites darwini var. *abbrevians* Kittl, 1903: 62; Spath, 1934: 372.

Tirolites spinosior Kittl, 1903: 62, pl. 11, fig. 5; Diener, 1915: 279.

Ceratites smiriagini Auerbach, 1871: 50, pl. 4, figs. 9–11.

Tirolites smiriagini,—Mojsisovics, 1882: 73, pl. 81, figs. 1, 2; Kittl, 1903: 63, pl. 11, fig. 6;

Diener, 1915: 279; Spath, 1934: 372.
Tirolites kernerii Kittl, 1903: 64, pl. 11, fig. 8;
 Diener, 1915: 278; Spath, 1934: 373.
Tirolites toulai Kittl, 1903: 64, pl. 11, figs. 11, 12;
 Diener, 1915: 280; Spath, 1934: 358, 379.
Tirolites (Scilajites) tietzei Kittl, 1903: 66, pl. 10,
 fig. 9; Diener, 1915: 281.
Ceratites (Paraceratites) prior Kittl, 1903: 29, pl.
 11, figs. 4, 13.
Xenodiscus prior,—Diener, 1915: 314.
Tirolitoides prior,—Spath, 1934: 378, fig. 127;
 Kummel, in Arkell, et al., 1957: L147, fig.
 180, 5.
Tirolites bispinatus Ganey, 1966: 25, pl. 1, fig. 5.

The species *cassianus* includes all the species that had been included by Mojsisovics and Kittl in the *Spinosi*. In general the representatives of this species have ribs associated with the ventrolateral tubercles. There are, however, gradational forms to *idrianus*. Measurements of 31 specimens from the Werfen Formation of Muć, Dalmatia, are given on Table 45 and plotted on Figure 41. Very few specimens of this species in the Kittl collection that were not figured are sufficiently well preserved to yield useful measurements; this accounts for the fewer measurements of this species than of *idrianus*. The many species of this group were differentiated on differences in ornamentation and suture. There appears, however, to be complete transition among the various so-called species in these and other characters.

The types of *Tirolitoides prior* owe their umbilical tubercles to preservation. The suture likewise is no different from that of several other tirolitids (Fig. 40B).

The type specimen of *Tirolites (Scilajites) tietzei* Kittl, with its ventral cross-ribs, is no more than a typical tirolitid. Many other specimens have similar cross-ribs on the venter though generally not as well developed as in the type specimen of *tietzei*.

The binodal aspect of *Tirolites bispinatus* Ganey (1966) is apparently due to the crushed nature of the specimen. There is a plaster cast of the holotype, and only specimen, in the Museum of Comparative Zoology.

Occurrence. Werfen Formation of the

Alps, Dalmatia and the associated regions. Also reported from eastern Bulgaria, from southern U.S.S.R. at Bogdo, Mangyshlak Peninsula, and Tuarkyr.

Repository. The specimens studied here are from the Kittl (1903) collection which is in the Natural History Museum, Vienna.

Tirolites cingulatus Kittl Plate 70, figures 8–9

Tirolites (Scilajites) cingulatus Kittl, 1903: 65,
 pl. 8, fig. 18; Diener, 1915: 280.
Scilajites cingulatus,—Spath, 1934: 380, fig. 129;
 Kummel, in Arkell, et al., 1957: L147, fig.
 180, 1.

The type species of *Scilajites* is *cingulatus*. The type specimen measures 37.3 mm in diameter, 10.3 mm for the width of the adoral whorl, 14.6 mm for the height, and the umbilicus is 13.2 mm in diameter. It is really only on the venter and one side of the last half volution that the shape and pattern of ornament are of at least fair preservation. The prior volutions and the opposite side from that shown on Plate 70, figure 9, are completely destroyed by weathering. The adoral half volution has two radial ribs extending from the umbilical shoulder to the ventral shoulder. These ribs presumably cross the venter, but on the type specimen this region of the venter is broken. An unfigured paratype in the collection of the Natural History Museum, Vienna, is weathered and poorly preserved but does show the ribs crossing the venter.

The second species that Kittl assigned to his subgenus *Scilajites* is *tietzei*, and it is illustrated here on Plate 70, figures 11, 12. The type specimen measures 41.7 mm in diameter, 12.8 mm for the width of the adoral whorl, 16.6 mm for the height, and the umbilicus is 16.9 mm in diameter. This is a typical tirolitid of much better preservation than the type specimen of *cingulatus*. There are broad folds extending across the venter from the ventro-lateral nodes. There is an indication that these cross folds decrease in prominence adorally. The general features of this species and especially the folds across the venter are to be seen

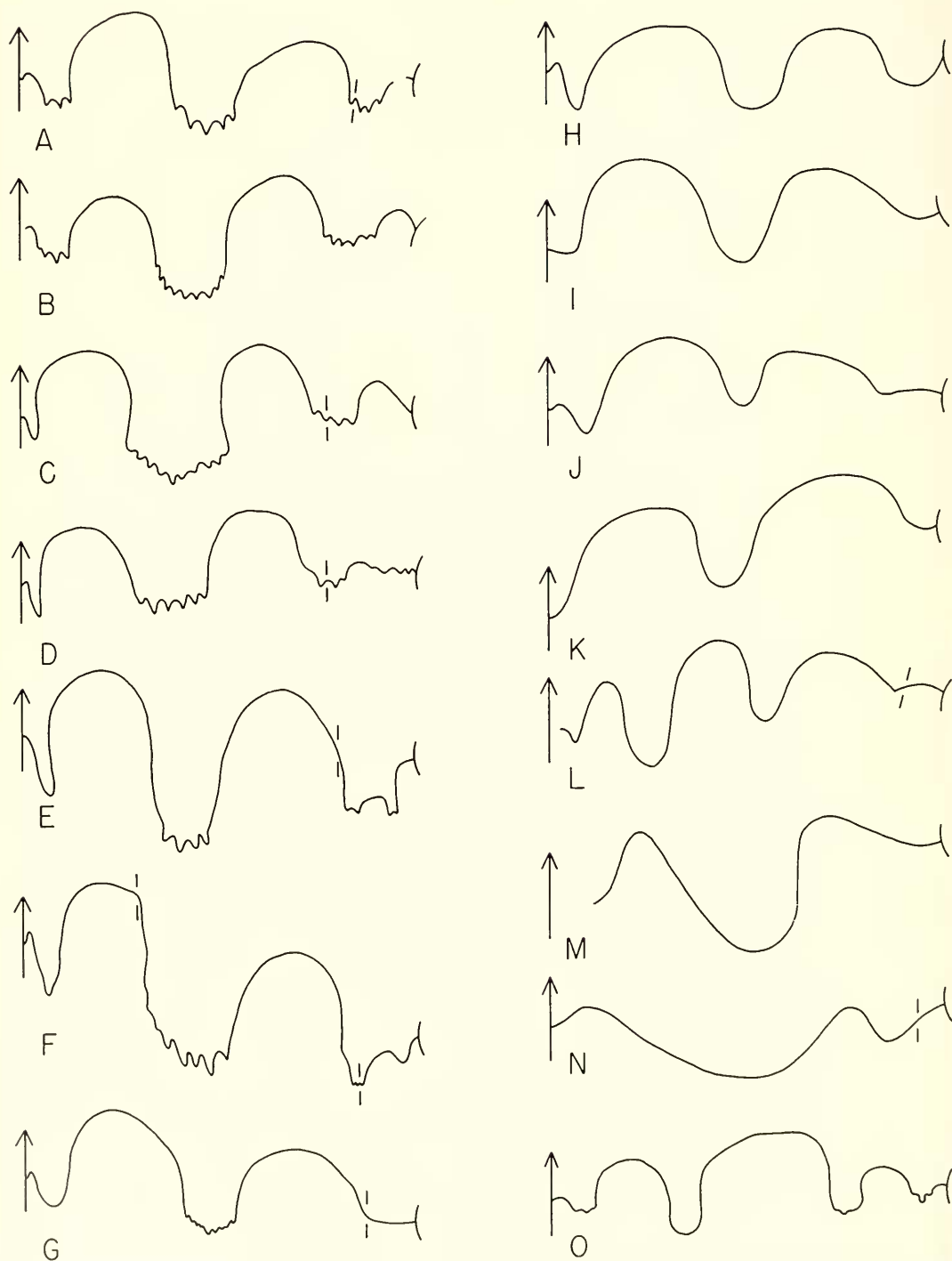


Figure 40. Diagrammatic representation of the suture of: A, *Tirolites toulai* Kittl [1903: pl. 11, fig. 11], at a diameter of 45 mm; B, paratype *Tirolitoides priar* (Kittl, 1903: pl. 11, fig. 4b), at a diameter of 35 mm; C, *Tirolites impolitus* Astakhova (1960a: fig. 16); D, *Tirolites elegans* Astakhova [1960a: fig. 15]; E, *Tirolites* cf. *cassianus* (Pl. 34, figs. 9, 10), at a whorl

TABLE 45. MEASUREMENTS OF SPECIMENS OF *TIROLITES CASSIANUS* (QUENSTEDT) FROM MUĆ IN DALMATIA STUDIED BY ERNST KITTL, 1903. ALL SPECIMENS ARE DEPOSITED IN THE NATURAL HISTORY MUSEUM, VIENNA.

	D	W	H	U	W/D	H/D	U/D		D	W	H	U	W/D	H/D	U/D
1.	85.0	21.5	28.5	37.2	26.7	33.5	43.8	17.	49.8	13.1	17.7	21.0	26.3	35.5	42.2
2.	76.0	16.6	26.5	34.0	21.8	34.9	44.7	18.	49.0	15.3	15.6	21.2	31.2	31.8	43.3
3.	66.0	16.8	22.9	28.2	25.5	34.7	42.7	19.	49.0	17.0	17.3	20.7	34.7	35.3	42.2
4.	65.0	17.2?	22.5	27.2	26.5?	34.6	41.8	20.	47.7?	?	15.2	22.1	?	31.9?	46.3
5.	59.5	14.8	21.2	26.0	24.9	35.6	43.7	21.	47.1	?	16.3	20.6	?	34.6	43.7
6.	59.3	19.3	20.7	24.2	32.5	34.9	40.8	22.	46.7	15.7	17.8	17.7	33.6	38.1	37.9
7.	58.7	20.0	20.8	25.0	34.1	35.4	42.6	23.	46.6	?	9.1?	22.8	?	19.5	48.9
8.	57.0	15.5?	20.1	22.4	27.2?	35.3	39.3	24.	46.2?	13.0	15.6	20.7	28.1?	33.8?	44.8?
9.	56.6	15.3	15.4	21.7	27.0	27.2	38.3	25.	45.0	11.3	14.2	20.9	25.1	31.6	46.4
10.	56.3	17.7	19.1	24.0	31.4	33.9	42.6	26.	43.6	11.0?	15.7	19.5	25.2?	36.0	44.7
11.	55.7	14.7	19.3	23.7	26.4	34.6	42.5	27.	43.5	15.2	15.6	17.2	34.9	35.9	39.5
12.	55.0	17.0	18.6	23.2	30.9	33.8	42.2	28.	42.2	?	9.6	18.0	?	22.7	42.7
13.	51.0	17.2	17.3	22.8	33.7	33.9	44.7	29.	40.5	10.3?	13.7	18.4	25.4?	33.8	45.4
14.	50.4	16.3	17.0	20.7	32.3	33.7	41.1	30.	38.4	12.4	12.8	17.4	32.3	33.3	45.3
15.	50.4	13.5	17.2	20.7	26.8	34.1	41.1	31.	36.6	10.1	12.9	14.1	27.6	35.2	38.5
16.	50.2	10.2	17.6	21.3	20.3	35.1	42.4								

1. Plesiotype, *T. darwini*,—Kittl (1903: pl. 10, fig. 11).
2. Lectotype, *T. spinosior* Kittl (1903: pl. 11, fig. 5).
3. Plesiotype, *T. darwini*,—Kittl (1903: pl. 11, fig. 1).
4. Plesiotype, *T. darwini* var. *costatus* Kittl (1903: pl. 11, fig. 2).
5. Syntype, *T. toulai* Kittl (1903: pl. 11, fig. 11).
6. Plesiotype, *T. haueri*,—Kittl (1903: pl. 9, fig. 10).
7. Plesiotype, *T. turgidus*,—Kittl (1903: pl. 10, fig. 8).
8. Plesiotype, *T. haueri*,—Kittl (1903: pl. 9, fig. 9).
9. Lectotype, *T. percostatus* Kittl (1903: pl. 10, fig. 6).
- 10, 12, 14, 15. Unfigured specimens, *T. haueri*,—Kittl (1903: 56).
11. Plesiotype, *T. spinosus*,—Kittl (1903: pl. 9, fig. 7).
13. Plesiotype, *T. haueri*,—Kittl (1903: pl. 9, fig. 13).
16. Plesiotype, *T. cassianus*,—Kittl (1903: pl. 9, fig. 4).
17. Figured specimen, *T. darwini* var. *modestus* Kittl (1903: pl. 11, fig. 7).
18. Plesiotype, *T. haueri*,—Kittl (1903: pl. 9, fig. 8).
19. Plesiotype, *T. haueri*,—Kittl (1903: pl. 9, fig. 12).
20. Plesiotype, *T. smiriagini*,—Kittl (1903: pl. 11, fig. 6).
21. Lectotype, *T. angustilobatus* Kittl (1903: pl. 9, fig. 3).
22. Figured specimen, *T. haueri* var. *minor* Kittl (1903: pl. 10, fig. 1).
23. Figured specimen, *T. angustilobatus* var. *alpha* Kittl (1903: pl. 9, fig. 1).
24. Figured specimen, *T. darwini* var. *reminiscens* Kittl (1903: pl. 10, fig. 5).
25. Figured specimen, *T. darwini* var. *cinctus* Kittl (1903: pl. 10, fig. 4).
26. Plesiotype, *T. cassianus*,—Kittl (1903: pl. 9, fig. 6).
27. Figured specimen, *T. haueri* var. *minor* Kittl (1903: pl. 10, fig. 3).
28. Plesiotype, *T. cassianus*,—Kittl (1903: pl. 9, fig. 5).
29. Figured specimen, *T. angustilobatus* var. *alpha* Kittl (1903: pl. 8, fig. 19).
30. Figured specimen, *T. haueri* var. *minor* Kittl (1903: pl. 10, fig. 2).
31. Figured specimen, *T. darwini* var. *cinctus* Kittl (1903: pl. 11, fig. 3).

height of 19 mm; F, *Tirolites* sp. indet. II (Pl. 55, figs. 4, 5), at a whorl height of 14 mm (MCZ 9502); G, holotype *Tirolites astakhovi* n. sp. (Pl. 55, figs. 1, 2), at a diameter of 45 mm (USNM 153081); H, *Dinarites dalmatinus*,—Kittl (1903: pl. 2, fig. 4), at a diameter of approximately 40 mm; I, *Dinarites dalmatinus*,—Kittl (1903: pl. 3, fig. 3), at a diameter of approximately 30 mm; J, *Dinarites dalmatinus*,—Kittl (1903: pl. 2, fig. 2), at a diameter of approximately 26 mm; K, holotype *Halalobus monaptychus* (Kittl, 1903: pl. 4, fig. 9), at a diameter of approximately 40 mm; L, holotype *Pseudokymatites svilajanus* Kittl (1903: pl. 4, fig. 3), at a diameter of approximately 40 mm; M, *Dinarites undatus* Astakhova (1960a: fig. 17), at a diameter of approximately 25 mm; N, *Dinarites liatsikasi* Renz and Renz (1948: pl. 1, fig. 3c); O, *Daricranites bogdoanus* [Mojsisovics, 1882: pl. 80, fig. 4], at a diameter of approximately 80 mm.

Specimens of figures A, B, H, I, J, K, L from Werfen Formation, Dalmatia; of C, D, M from upper Scythian strata Mangyshlak Peninsula; of N, from *Subcalumbites* fauna of Chios; of O, from upper Scythian strata Mount Bogdo, southern Russia; E, Upper Thynnes Formation, Confusion Range, Utah; F, G, *Calumbites* fauna southeastern Idaho.

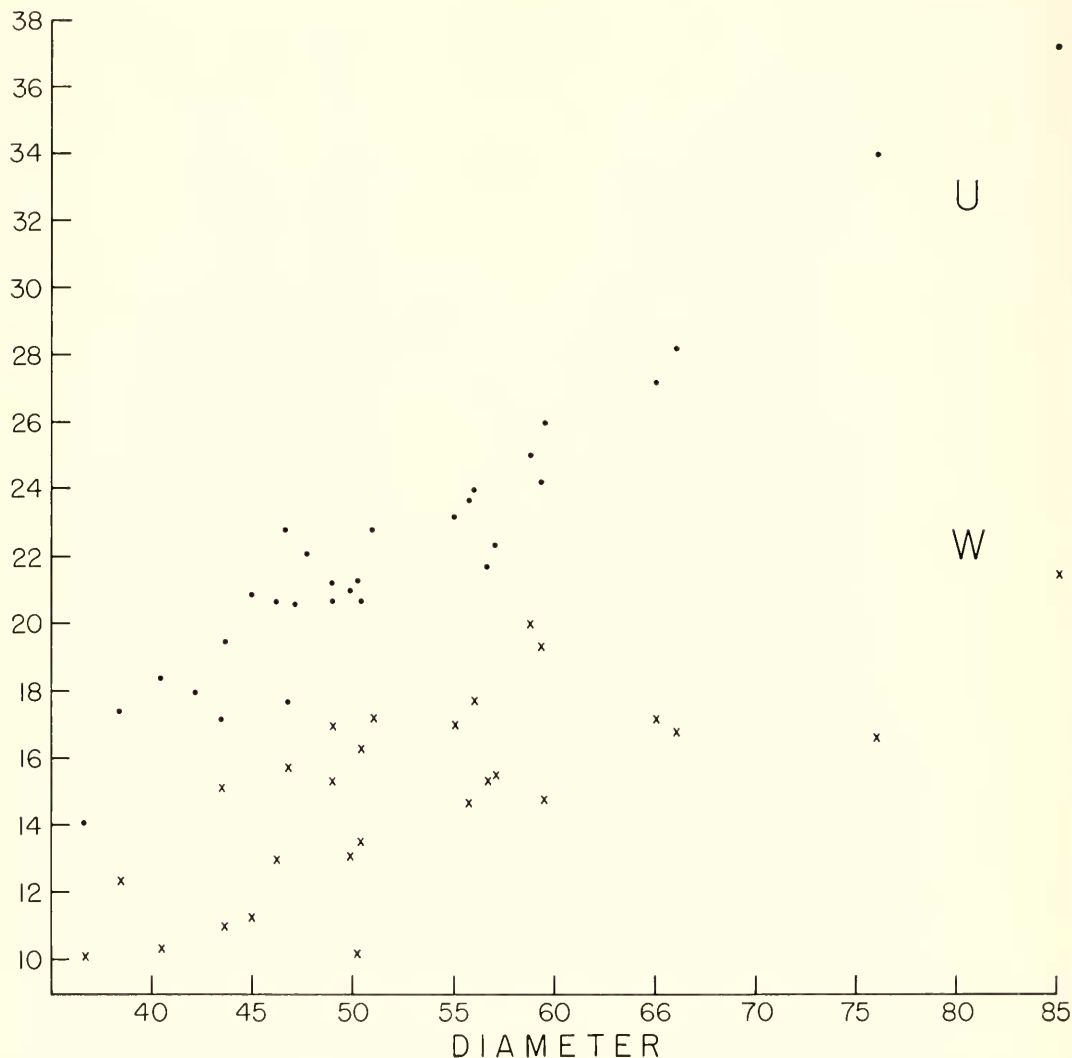


Figure 41. Variation in whorl width (W) and umbilical diameter (U) in *Tirolites cassianus* (Quenstedt), from the Werfen Formation of Muć, Dalmatia. The data on this graph are from Table 45.

in several of the so-called species of *Tirolites* of the Spinosi. The ventral ridges are related in some degree to the general prominence of the ventro-lateral nodes. The species *tietzei* belongs in the synonymy of *Tirolites cassianus*.

The species *cingulatus* is thus known from only two poorly preserved specimens. These appear to be distinct from the highly variable *Tirolites cassianus* at a specific level but not at a generic level as has been advocated.

Occurrence. Werfen Formation, Muć, Dalmatia.

Repository. Natural History Museum, Vienna.

Tirolites rossicus Kiparisova Text-figure 40

Tirolites rossicus Kiparisova, 1947: 168, pl. 43, figs. 2, 3, pl. 44, fig. 2, text-fig. 66; Shevyrev and Shlezinger, 1960: 1418.

Tirolites elegans Astakhova, 1960a: 150, pl. 35, fig. 1; text-fig. 15.

A robust species that in its slightly

prospiradate ribs on the inner whorls reminds one of the specimens assigned to *T. cf. cassianus* from the Thaynes Formation of the Confusion Range (Pl. 34, figs. 7–10). This species is clearly a member of the Spinosi and is said by Astakhova (1960a) to be associated with *T. cassianus* and *T. spinosus*. The suture of *T. elegans* Astakhova is illustrated on Figure 40D.

Occurrence. *Tirolites* Zone of Astakhova (1960a), Mangyshlak Peninsula.

Tirolites impolitus Astakhova

Text-figure 40

Tirolites impolitus Astakhova, 1960a: 151, pl. 35, fig. 5, text-fig. 16.

This species comes from a horizon approximately 150 m above that which yielded *T. rossicus*. It differs from that species primarily in having more prominent ribs and nodes. Too few data are available as yet on the Mangyshlak fauna. At the moment it seems best to accept this species; a great deal more collecting and study are needed of these forms. The suture is shown on Figure 40C.

Occurrence. *Tirolites* Zone of Astakhova (1960a), Mangyshlak Peninsula.

Tirolites morpheos (Popov)

Columbites morphcos Popov, 1961, p. 28, pl. 13, fig. 8.

Popov assigned this species (based on two specimens) to the genus *Columbites* on the strength of an apparent similarity of the suture to that of *Columbites parisi-anus*. Popov, however, was not aware of the tremendous variation that is present in the suture of *Columbites parisi-anus* (Fig. 22). This suture is quite similar to that of *Tirolites* in basic plan. A more reliable indicator of genetic affinity is the ornamental pattern. In this respect the species *morpheos* is clearly a tirolitid.

Popov (1961) described two other tirolitids from Siberia on the basis of single fragmentary and poorly preserved specimens. Both specimens were collected from

alluvium in the basin of the Kolyma River, Siberia. These two species—*T. ex gr. cassianus*, Popov (1961: 29, pl. 13, fig. 7) and *T. gerbaensis* Popov (1961: 29, pl. 13, fig. 5)—because of poor preservation and lack of stratigraphic data are included in the list of unrecognizable species.

Occurrence. Olenek stage, basin of Kolyma River, Siberia.

Tirolites harti Smith

Plate 71, figures 1–7

Tirolites harti Smith, 1932: 83, pl. 57, figs. 9, 10.

Tirolites knighti Smith, 1932: 84, pl. 57, figs. 1–4.

Tirolites pealei Smith, 1932: 84, pl. 57, figs. 5–8.

Smith (1932) clearly recognized that the few fragmentary specimens of *Tirolites* he had from the *Tirolites* Zone in Paris Canyon were closely related to, if not conspecific with, various species of the Spinosi of the Werfen Formation. In this conclusion I am in complete agreement. However, along with Smith, I believe it best to keep these Idaho forms under a separate species name because the fragmentary specimens known to date do not allow any kind of critical analysis.

Occurrence. *Tirolites* Zone, Thaynes Formation, Paris Canyon, southeast Idaho.

Repository. Holotype, USNM 75022; *T. knighti*, holotype, USNM 75020a; paratype, USNM 75020b; *T. pealei*, holotype USNM 75021a; paratype, USNM 75021; topotypes MCZ 9641.

Tirolites smithi n. sp.

Plate 54, figures 1–5

Tirolites illyricus Mojsisovics, Smith, 1932: 84, pl. 49, figs. 12–16.

Smith (1932) had a single specimen from the *Columbites* fauna of Paris Canyon, southeast Idaho, that he assigned to Mojsisovics' species—*illyricus*. There is a general resemblance to *T. illyricus* as there is to many other closely similar Werfen Formation forms. The Idaho species, however, has a very different aspect. First of all, Smith's specimen has fine radial ribs

on the inner whorls, that decrease adorally; on the outer volution the ribs are gone and only sinuous growth lines are present with widely spaced tubercles at the ventral shoulders; the venter is highly vaulted. Two additional specimens have since been uncovered which are of special interest. There is first of all a small juvenile form (Pl. 54, figs. 4, 5) measuring 31.4 mm in diameter, 9.3 mm for the width of the adoral whorl, 11.2 mm for the height, and the umbilicus is 12.8 mm in diameter. The radial ribs on the inner whorls and the gradual adoral decrease in rib prominence are well displayed on this specimen. The ventral nodes are already well developed on the outer whorl of this specimen. The second specimen is a large one measuring 102 mm in diameter, 32.7 mm for the width of the adoral whorl, 39.5 mm for the height, and the umbilicus is 35.3 mm in diameter. The adoral half volution appears to be body chamber. This portion of the conch is still characterized by the prominent ventral tubercles and sinuous growth lines.

The sum total of the characters of this form set it apart from any of the Werfen Formation species of *Tirolites*. It likewise is totally different from *Tirolites astakhovi* which also occurs in the *Columbites* fauna of southeastern Idaho but at a different locality from where this species has been found.

Occurrence. The holotype (Pl. 54, figs. 2, 3) comes from the *Columbites* fauna, Thaynes Formation, Paris Canyon, southeast Idaho. The two plesiotypes recorded here (Pl. 54, figs. 1, 4, 5) come from the same horizons in Montpelier Canyon, southeast Idaho.

Repository. Holotype (Pl. 54, figs. 2, 3) USNM 74993; plesiotypes (Pl. 54, fig. 1) MCZ 9547, (Pl. 54, figs. 4, 5) MCZ 9548.

Tirolites astakhovi n. sp.

Plate 55, figures 1–3; Text-figure 40

Three excellently preserved specimens from the *Columbites* fauna of southeast

Idaho are the basis for this new species. The measurements of the specimens are as follows.

	D	H	W	U
Holotype USNM 153081	51.5	14.3	?	26.0
Paratype Unfigured	82.4	22.2	?	42.2
Paratype USNM 153082	38.8	10.6	9.5	21.8

The conch is widely umbilicate with sub-rectangular whorl sections. The lateral areas are flattened, and the venter broadly arched. Both the ventral and umbilical shoulders are rounded. The lateral areas bear slightly prosiradiate ribs that begin on the umbilical shoulder and terminate at the ventral shoulder in a prominent node. On the smallest of the available specimens the nodes are much more prominent than on the other two specimens. Likewise on this small specimen the lateral areas are slightly divergent.

The suture of the holotype is illustrated on Figure 40G. The first lateral lobe lies just above the node on the ventral shoulder and the second lateral lobe lies on the umbilical shoulder and wall.

The morphological variations possible within species of the genus *Tirolites* were impressively illustrated by Kittl in his well-known monograph on the upper Werfen fauna from Muć. There is a strong temptation to assign these forms to one of the species described by Kittl. In fact, there is a marked morphological similarity with practically all of the thirteen species Kittl (1903: 52, 53) included in the Spinosi. The separation of this form from the Werfen species is done more as a matter of convenience than of conviction. More Idaho *Columbites* Zone material is needed, and the pattern of intraspecific variation in the Werfen species needs to be better understood before the relationships can be approached objectively.

Occurrence. From middle shale member of Thaynes Formation (*Columbites* fauna), on hillside north of Sage Creek, Stewart Flat Quadrangle, southeast Idaho.

Repository. Holotype, USNM 153081

(Pl. 55, figs. 1–2); figured paratype, USNM 153082 (Pl. 55, fig. 3); unfigured paratype USGS collections.

Tirolites cf. *cassianus* (Quenstedt)

Plate 34, figures 7–10; Text-figure 40

Tirolites cf. *spinosus* Mojsisovics,—Silberling, in Hose and Repenning, 1959: 2194.

Tirolites aff. *haueri* Mojsisovics,—Silberling, in Hose and Repenning, 1959: 2194.

The two specimens recorded here are clearly representatives of the *Spinosi* and could well be conspecific with the Werfen Formation species—*cassianus*. These specimens can be matched readily with several of the specimens illustrated by Kittl (1903). However, because the sample consists of only two fragmentary specimens it appears best to do no more than indicate a close affinity to the Werfen Formation species. The suture is shown on Figure 40E.

Occurrence. Thaynes Formation, Confusion Range, sample M111 in Hose and Repenning (1959, p. 2194).

Repository. USNM 153083 (Pl. 34, figs. 7, 8), USNM 153084 (Pl. 34, figs. 9, 10).

Tirolites sp. indet. II

Plate 55, figures 4, 5; Text-figure 40

A single specimen, consisting of approximately one half volution and much of the inner whorls, is clearly a tirolitid, but of uncertain specific affinities. The conch is evolute, with whorls that are about as wide as high on the earlier volutions but gradually become more compressed and higher than wide. The outer half volution of the specimen is half phragmocone and half body chamber. The lateral areas are flattened and the venter is broadly rounded. Both the ventral and umbilical shoulders are rounded. The umbilical wall slopes to the seam at an angle of approximately 45 degrees. The lateral areas bear widely spaced nodes which lie just dorsal of the ventral shoulders. There are approximately seven such nodes on the adoral half volution, and these show marked increase in

size adorally. The shell bears sinuous growth lines that are slightly prosiradiate on the lateral areas and strongly projected forward in a broad arc over the venter.

The inner whorls, up to a diameter of 10 mm, are approximately as high as wide and the lateral areas bear radial ribs, some of which terminate in weak nodes at the ventral shoulder. On the next volution, that is, to a diameter of 20 mm, the whorls gradually increase in height, and the ornament consists only of widely spaced (four per half volution) conspicuous nodes at the umbilical shoulder.

The suture is shown on Figure 40F. The large first lateral lobe enclosed the ventrolateral node, and the second lateral lobe is on the umbilical wall. It is not difficult to find, among the numerous Werfen specimens illustrated by Kittl (1903), forms which are quite similar to the one mentioned here. However, because I am dealing with a single specimen, it seems best to merely document the occurrence of this form.

Occurrence. Middle shale member of Thaynes Formation (*Columbites* fauna), Montpelier Canyon, southeast Idaho.

Repository. MCZ 9502.

Genus *Diaplococeras* Hyatt

Type species, *Ceratites liccanus* Hauer, 1865
Diaplococeras liccanum (Hauer)

Ceratites liccanus Hauer, 1865: 616, pl. 3, figs. 1–3.

Dinarites liccanus,—Mojsisovics, 1882: 10, pl. 4, fig. 1; Tommasi, 1895: 69, pl. 4, fig. 14.

Diaplococeras liccanum,—Hyatt, 1900: 556; Spath, 1934: 379, fig. 128; Kummel, in Arkell et al., 1957: L147, fig. 180, 6.

Dinarites (*Licaites*) *liccanus*,—Kittl, 1903: 26; Diener, 1915: 123.

Hauer (1865) based his species on one specimen. Mojsisovics apparently had three specimens for study; however, none of these specimens were available for study to the writer.

Occurrence. Werfen Formation, Muć, Dalmatia.

Diaplococeras connectens* (Mojsisovics)*Plate 62, figures 1–4**

- Dinarites* (*Ceratites*) *connectens* Mojsisovics, 1882: 9, pl. 3, fig. 10.
Dinarites (*Liccaites*) *connectens*,—Kittl, 1903: 25; Diener, 1915: 123.
Diaplococeras connectens,—Spath, 1934: 380.
Dinarites circumplicatus Mojsisovics, 1882: 8, pl. 3, figs. 8, 9.
Dinarites (*Liccaites*) *circumplicatus*,—Kittl, 1903: 24; Diener, 1915: 123.
Diaplococeras circumplicatus,—Spath, 1934: 380.
Dinarites biangulatus Kittl, 1903: 16, pl. 4, fig. 1; Diener, 1915: 120.
Dinarites (*Hercegovites*) *diocletiani* Kittl, 1903: 23, pl. 3, fig. 4; Diener, 1915: 122; Spath, 1934: 388.
Dinarites (*Liccaites*) *progressus* Kittl, 1903: 26, pl. 4, fig. 2; Diener, 1915: 123; Spath, 1934: 123.
Dinarites progressus,—Ganev, 1966: 27, pl. 2, fig. 2.

Poor preservation and misleading illustrations account for at least some of the confusion that has surrounded the species brought together here. The Werfen Formation contains a compressed form of ammonite that is modestly involute with low arched venter and conspicuous umbilical shoulder and umbilical wall. The suture is ceratitic with two lateral lobes. The flanks bear slightly prosiradiate ribs. Five species have been established for ammonites of the above general design. The major difference between these "species" is in their state of preservation. The specimens of the two species described by Mojsisovics—*connectens* and *circumplicatus*—were not personally studied. The three species established by Kittl (1903) were studied in detail.

The holotype of *Dinarites diocletiani* is shown here on Plate 62, figure 1. The specimen is crushed and the opposite side from that shown in the photograph has been destroyed by weathering. There are low, narrow, prosiradiate ribs on the flanks that are most conspicuous at and near the umbilical shoulder and decrease toward the ventral shoulder. The ribs also decrease in intensity adorally.

The holotype of *Dinarites biangulatus* is shown here on Plate 62, figures 3, 4. This specimen is highly weathered and only the body chamber approximates the original size and shape; the phragmocone is completely distorted by weathering. The basic outline of the whorls, degree of involution, and pattern of the suture (taking into account the weathering) is like that of *D. diocletiani*. The weathered body chamber has faint indications of ribs.

The holotype of *Dinarites progressus* Kittl, is shown here on Plate 62, figure 2. As can be seen, it also is a highly weathered specimen in which all surface features are obliterated or altered. In shape of whorl section, degree of involution and suture, it appears surely to be conspecific with the other forms included in this species.

The forms brought together here as *D. connectens* differ from *D. liccanum* in lacking peripheral clavi and umbilical tubercles.

Occurrence. Werfen Formation, Muć, Dalmatia, and eastern Bulgaria.

Repository. The specimens described by Kittl are in the Natural History Museum, Vienna. The specimen described by Ganev (1966) is in the Geological Institute of the Bulgarian Academy of Science; a plaster cast is in the Museum of Comparative Zoology.

Genus *Bittnerites* Kittl

Type species, *Tirolites* (*Bittnerites*) *bittneri* Kittl, 1903

***Bittnerites bittneri* (Kittl)**

Plate 57, figures 1–6

- Tirolites* (*Bittnerites*) *bittneri* Kittl, 1903: 67, pl. 11, fig. 10; Diener, 1915: 280.
Bittnerites bittneri,—Spath, 1934: 381, fig. 130.
 Kummel, in Arkell, et al., 1957: 1147, fig. 180, 3.
Tirolites (*Bittnerites*) *malici* Kittl, 1903: 67, pl. 3, fig. 8; Diener, 1915: 280.
Bittnerites malici,—Spath, 1934: 381, fig. 130.
Tirolites (*Bittnerites*?) *telleri* Kittl, 1903: 68, pl. 10, fig. 10; Diener, 1915: 280.

Of the three species Kittl (1903) assigned to his new genus *Bittnerites*, only

the illustrated specimen of each species is still preserved. The genotype specimen—*B. bittneri*—is weathered, measuring 50.5 mm in diameter, 12.3 mm for the width of the adoral whorl, 17.7 mm for the height, and 23.1 mm for the diameter of the umbilicus. None of the inner whorls are preserved. Kittl (1903: pl. 11, fig. 10) shows the venter to be sharpened; this, however, is entirely due to weathering. The normal condition of the venter is rounded. The large specimen which represents the type of *Bittnerites malici* is of slightly better preservation in that at least the inner whorls are preserved. This specimen measures 71.1 mm in diameter, 17.2 mm for the width of the adoral whorl, 23.1 mm for the height, and the umbilicus is 30.6 mm in diameter. Kittl (1903: pl. 2, fig. 8) shows prominent prosiradiate shallow constrictions at least on the body chamber of the specimen. A photograph of the specimen reproduced here on Plate 57, figure 3, shows no such furrows. It should again be emphasized that preservation of the Werfen Formation ammonites leaves much to be desired and fine surface details are seldom preserved.

The type specimen of *Bittnerites telleri* is a very poorly preserved specimen consisting only of the outer volution. It measures 59.0 mm in diameter, 17.3 mm for the width of the adoral whorl, 18.7 mm for the height, and the umbilicus is 25.4 mm in diameter. The prosiradiate shallow furrows are visible on part of the outer volution. This specimen differs from the type specimen of *B. malici* only in having slightly more inflated whorls; there is no justification for keeping these specimens in separate species.

The genus *Bittnerites* is known only from its type species.

Occurrence. Werfen Formation, Muć, Dalmatia.

Repository. Natural History Museum, Vienna.

Genus *Doricranites* Hyatt, 1889

Type species, *Ammonites bogdoanus* v. Buch, 1831

Doricranites bogdoanus (v. Buch)

Text-figure 40

Ammonites bogdoanus v. Buch, 1831: pl. 2, fig. 1; v. Buch, 1848: 16, pl. 5, figs. 6, 7.

Goniatis bogdoanus,—de Verneuil, in Murchison, Verneuil and Keyserling, 1845: 366, pl. 26, fig. 1.

Ceratites bogdoanus,—Auerbach, 1871: 49, pl. 4, figs. 1–8.

Balatonites bogdoanus,—Mojsisovics, 1882: 87, pl. 80, figs. 1–4.

Doricranites bogdoanus,—Hyatt, in Whiteaves, 1889: 145; Spath, 1934, p. 382, fig. 131; Kummel, in Arkell et al., 1957: L147, fig. 180, 2.

Doricranites bogdoanus,—Diener, 1915: 129; Kiparisova, 1947: 169, pl. 43, fig. 1; Astakhova, 1960a: 155; Astakhova, 1960b: 149; Shevyrev and Shlezinger, 1960: 1418; Astakhova, 1962: 70, 75.

Balatonites rossicus Mojsisovics, 1882: 89, pl. 80, fig. 5.

Doricranites rossicus,—Hyatt, in Whiteaves, 1889: 145.

Doricranites rossicus,—Diener, 1915: 129; Kiparisova, 1947: 170, pl. 43, fig. 4; Astakhova, 1960a: 154, 157; Astakhova, 1960b: 149; Shevyrev and Shlezinger, 1960: 1418; Astakhova, 1962: 75.

Doricranites tumulosus Astakhova, 1960a: 154, pl. 35, fig. 2, text-figs. 18, 19; Astakhova, 1960b: 149; Astakhova, 1962: 75.

Doricranites lanceolatus Astakhova, 1960a: 155, pl. 36, fig. 1, text-figs. 20, 21; Astakhova, 1960b: 149.

Doricranites schairicus Astakhova, 1960a: 156, pl. 36, fig. 2, text-figs. 22, 23; Astakhova, 1960b: 149; Astakhova, 1962: 75.

Doricranites ovatus Astakhova, 1960b: 149.

Doricranites discus Astakhova, 1960b: 149.

Doricranites rarecostatus Astakhova, 1960b: 149.

The criteria used to differentiate these several species of *Doricranites* are mainly ornamentation and shape of the whorl section. Examination of the few illustrations of these species suggests that the degree of ornamentation and compression of the conch are highly variable features. One gets the impression from Astakhova's discussion of the stratigraphy of the Scythian formations of the Mangyshlak Peninsula that *Doricranites* is a common fossil and

that most if not all of the species listed above occur together. On the basis of experiences with other ornamented Scythian ammonoids in which large numbers of specimens are available, it appears much more plausible that the species listed in the synonymy are part of a single species complex characteristic of a particular horizon in southern U.S.S.R. The only other species assigned to this genus is *D. acutus* which is considerably more involute. The suture of *D. bogdoanus* is illustrated on Figure 400.

Occurrence. Scythian strata, Mount Bogdo, Mangyshlak Peninsula, and region of Tuarkyr in Turkmenia, southern U.S.S.R.

Doricranites acutus (Mojsisovics)

Balatonites acutus Mojsisovics, 1882: 89, pl. 80, fig. 6.

Dorikranites acutus,—Hyatt, in Whiteaves, 1889: 145.

Doricranites acutus,—Diener, 1915: 129; Astakhova, 1960a: 159; Schevyrev and Shlezinger, 1960: 1418.

Subdoricranites discoides Astakhova, 1960a: 158, pl. 35, figs. 3, 4, text-fig. 24 (*nomen nudum* of Bajarunas, 1936).

Subdoricranites orbiculatus Astakhova, 1964: 380, pl. 1, fig. 2.

This species differs from *bogdoanus* in being more compressed, more involute, and generally with a more subdued pattern of ornamentation.

Occurrence. This species along with *D. bogdoanus* is apparently quite common in the *Doricranites* Zone of Astakhova (1960a, b, 1962) at Mount Bogdo, Mangyshlak Peninsula, and the region of Tuarkyr in Turkmenia.

Family DINARITIDAE Mojsisovics, 1882

Genus *Dinarites* Mojsisovics, 1882

Type species, *Ceratites dalmatinus* Hauer, 1865

I recognize here four species of *Dinarites*, all confined to the western region of Tethys. The genus is an important member of the Werfen fauna where it is represented by

two species. One of these (*carniolicus*) is the type species of *Carniolites*; this genus is considered to be a synonym of *Dinarites*. The presence of *Dinarites dalmatinus* in the *Subcolumbites* fauna of Chios is an important link in dating the Werfen fauna. The other two species of *Dinarites* (*liatsikasi* and *undatus*) are quite distinct from *dalmatinus* and *carniolicus* but closely related to each other. *Dinarites liatsikasi* is from the *Subcolumbites* fauna of Chios and *D. undatus* from the upper Scythian formations of the Mangyshlak Peninsula.

Dinarites dalmatinus (Hauer)

Plate 58, figures 1–10; Plate 59, figures 1–11; Plate 60, figures 1–8; Text-figure 40

Ceratites dalmatinus Hauer, 1865: 615, pl. 2, figs. 3, 4.

Dinarites dalmatinus,—Mojsisovics, 1882: 8, pl. 1, figs. 7, 8; Kittl, 1903: 18, pl. 2, figs. 1–11, pl. 3, figs. 1, 2; Hyatt and Smith, 1905: 162; Arthaber, in Frech, 1906: pl. 34, fig. 17; Diener, 1915: 120; Kummel, in Arkell, et al., 1957: L148, fig. 181, 1; Ganev, 1961: 182, pl. 2, figs. 4, 5, 8, pl. 4, fig. 6, pl. 6, fig. 2.

Dinarites dalmatinus var. *extensus* Kittl, 1903: 20, pl. 2, figs. 8, 9.

Dinarites dalmatinus var. *plurimcostatus* Kittl, 1903: 20, pl. 2, figs. 10, 11.

Dinarites dalmatinus var. *externeplanatus* Kittl, 1903: 20, pl. 2, figs. 1, 2.

Plococeras dalmatinum,—Hyatt, 1900: 556; Spath, 1934: 388, fig. 134.

Dinarites nudus Mojsisovics, 1882: 6, pl. 1, figs. 5, 6; Kittl, 1903: 17, pl. 1, figs. 11–13; Diener, 1915: 122; Renz and Renz, 1948: 48, pl. 1, figs. 1, 2.

Dinarites laevis Tommasi, 1902: 347, pl. 13, figs. 4, 5; Kittl, 1903: 13, pl. 1, figs. 1–3, pl. 3, figs. 10, 11; Diener, 1915: 121; Spath, 1934: 386.

Ceratites muchianus Hauer, 1865: 613, pl. 2, figs. 5, 6.

Dinarites muchianus,—Mojsisovics, 1882: 6, pl. 1, fig. 4; Kittl, 1903: 15, pl. 1, figs. 4–8; Arthaber, in Frech, 1906: pl. 34, fig. 16; Wittenburg, 1908: 285, pl. 40, fig. 20; Diener, 1915: 121; Spath, 1934: 386, fig. 132; Ganev, 1966: 26, pl. 1, figs. 3a–c.

Dinarites evolutionis Kittl, 1903: 16, pl. 1, figs. 9, 10; Diener, 1915: 121; Spath, 1934: 384; Renz and Renz, 1948: 49, pl. 1, fig. 4; Kollárová-Andrusovová, 1961: 29, pl. 3, fig. 2.

Dinarites (?) *angulatus* Kittl, 1903: 22, pl. 3, fig. 9.

Dinarites multicostatus Kittl, 1903: 21, pl. 3, fig. 3; Diener, 1915: 122.

Dinarites tirolitoides Kittl, 1903: 21, pl. 7, figs. 1-3; Diener, 1915: 122.

Dinarites bulgaricus Berndt, 1934: 8, pl. 2, fig. 8.

Aside from *Tirolites* the most common element in the Werfen Formation fauna of the Alps and associated regions is *Dinarites*. A number of species names have been introduced for the dinaritids of this region but basically there are two main species, the first, encompassing predominantly smooth forms (*muchianus*), and the second, ornamented forms with ribs (*dalmatinus*). This second species had been set aside early (Hyatt, 1900) as the type of *Plococeras*. The latter genus had been accepted by Diener (1915) and Spath (1934). However, the selection of *dalmatinus* as the type of *Dinarites* Mojsisovics (1882), by Hyatt and Smith (1905, p. 162), makes *Plococeras* a synonym of *Dinarites*. Whereas the earlier authors wished to separate the smooth and ornamented dinaritids into distinct genera, my own studies bring me to the conclusion that we are dealing here with a single species complex rather than several species in two different genera.

The largest single collection of Werfen Formation dinaritids is that studied by Kittl (1903) and on deposit in the Natural History Museum, Vienna. The measurements of 38 specimens are listed on Table 46 and plotted on Figure 42. These 38 specimens represent the most complete and best preserved specimens available to Kittl, who illustrated most of them. Practically all of the remaining specimens that Kittl assigned to this or that species of dinaritid are very poorly preserved and of somewhat doubtful value. Kittl's illustrations are line drawings of better than average quality but yet lacking in not conveying the nature of preservation, imperfections in the conch, and at times with errors in artistry. All of the earlier illustrations for the Werfen Formation dinaritids are line drawings (e.g. Mojsisovics, 1882), and most of the more modern illustrations

are impossible to decipher due to faulty printing and poor paper. Plates 58, 59, and 60 have photographic prints of the principal dinaritids studied by Kittl (1903). The smoothness of some of the specimens is clearly due to weathering and preservation. The number and intensity of the ribs is highly variable. Finally, there is a fair degree of variation in the diameter of the umbilicus (Fig. 42). Study of all of Kittl's specimens assigned to these species of dinaritids (smooth-*muchianus*; ribbed-*dalmatinus*) leads me to believe there is complete gradation from smooth to strongly ribbed forms. This observation plus the fact that all combinations of the morphological grades are found in nearly every fossiliferous locality in the Werfen Formation brings me to the conclusion we are dealing with a single, variable species.

The suture is illustrated on Figure 40H-J.

The dinaritids are a very small element in the *Subcolumbites* fauna of Chios. Renz and Renz (1948) record two specimens of *Dinarites nudus* Mojsisovics and two specimens of *Dinarites evolution* Kittl. These specimens fall well within the range of variability recognized for *Dinarites dalmatinus* and are thus considered synonyms. The two specimens assigned to *Dinarites liatsikasi* (Renz and Renz, 1948: 49, pl. 1, fig. 3) are of special interest for the close similarity they show to *Dinarites undatus* Astakhova (1960a) from the Mangyshlak Peninsula. Each of these species is distinct from *D. dalmatinus* in ornamentation and in suture.

Occurrence. Primarily in Werfen Formation of the Alps and related regions. A few specimens are known from the *Subcolumbites* fauna of Chios.

Repository. The Werfen Formation specimens are in the Natural History Museum, Vienna; those from the *Subcolumbites* fauna of Chios are in the Natural History Museum, Basel, NHMB J13683-6; the specimens from eastern Bulgaria recorded by Ganev (1961, 1966) are in the Geological Institute of the Bulgarian Academy of

TABLE 46. MEASUREMENTS OF *DINARITES DALMATINUS* (HAUER) FROM WERFEN FORMATION, MUĆ, DALMATIA. ALL SPECIMENS ARE IN NATURAL HISTORY MUSEUM, VIENNA; DATA PLOTTED ON GRAPH OF FIGURE 42.

	D	W	H	U	W/D	H/D	U/D		D	W	H	U	W/D	H/D	U/D
1.	63.7?	16.7	29.5	16.4	26.2	46.3	25.7	20.	45.4	14.4?	18.8	11.7	31.8	41.5	25.8
2.	59.7	?	27.1	14.4	?	45.5	24.1	21.	45.0	14.0	18.7	13.1	31.1	41.5	29.1
3.	58.7	16.8	26.0	16.4	28.6	44.3	27.9	22.	44.5	10.1	17.3	15.3	22.7	38.9	34.4
4.	56.4	?	23.9	15.7	?	42.4	27.8	23.	44.3	?	20.4	10.1	?	46.0	22.8
5.	56.2	?	25.3	13.0	?	45.0	23.1	24.	44.2	?	20.5	10.8	?	46.4	24.4
6.	55.6	16.6?	22.6	17.5	29.9	40.6	31.5	25.	44.0	8.5	20.7	8.4	19.3	47.0	19.1
7.	54.8?	?	24.8	14.7	?	45.1	26.8	26.	43.5	11.8?	17.4	11.0	27.1	40.0	25.3
8.	53.8	12.3	22.5	13.7	22.9	41.8	25.5	27.	42.8	13.3	16.8	12.8	31.1	39.3	29.9
9.	53.0	12.7	22.7	?	24.0	42.8	?	28.	41.8	?	20.1	6.4	?	48.1	15.3
10.	52.8	14.5	24.4	11.3	27.5	46.2	21.4	29.	41.7	13.0	17.2	11.9	31.2	41.2	28.4
11.	51.4	16.6	19.8	17.7	32.4	38.6	34.5	30.	41.4	9.5?	17.8	11.3	23.0	43.0	27.3
12.	51.4	11.8	23.0	11.2	22.9	44.7	21.8	31.	41.3	13.2	17.7	11.7	32.0	42.9	28.4
13.	50.6?	10.4?	20.8	9.1	20.6	41.1	18.0	32.	41.1	11.2	18.3	9.5	27.3	44.5	23.1
14.	49.0	14.1	21.1	15.0?	28.8	43.1	30.6	33.	39.5	12.3?	16.5	10.8	31.1	41.8	27.3
15.	47.8	?	21.2	12.8	?	44.4	26.8	34.	39.4	12.3	16.0	11.5	31.2	40.6	29.2
16.	47.4	?	24.6?	5.9?	?	52.0	32.3	35.	38.9	9.0	19.4	6.7	23.1	49.9	17.2
17.	47.0?	13.0	23.7	10.2	27.6	50.5	21.7	36.	37.5	6.8	16.3	10.0	18.1	43.5	26.6
18.	46.6	?	20.5	10.2	?	44.0	21.9	37.	34.7	?	15.5	9.2	?	44.7	26.5
19.	45.5	11.4	19.2	10.9	25.1	42.2	24.0	38.	26.2	6.3	13.5	3.8	24.4	51.5	14.5

1. Plesiotype,—Kittl (1903: pl. 2, fig. 5).
2. Plesiotype,—Kittl (1903: pl. 2, fig. 6).
3. Plesiotype,—Kittl (1903, pl. 2, fig. 4).
4. Plesiotype,—Kittl (1903, pl. 2, fig. 7).
5. Unfigured paratype, *Dinarites evolutioni* Kittl.
6. Unfigured paratype, *Dinarites multicostatus* Kittl.
7. Plesiotype,—Kittl (1903: pl. 2, fig. 1).
8. Unfigured paratype, *Dinarites evolutioni* Kittl.
9. Syntype, *Dinarites evolutioni* Kittl (1903: pl. 1, fig. 10).
10. Plesiotype, *Dinarites muchianus*,—Kittl (1903: pl. 1, fig. 6).
11. Figured type, *Dinarites tirolitoides* Kittl (1903: pl. 7, fig. 2).
12. Plesiotype, *Dinarites muchianus*,—Kittl (1903: pl. 1, fig. 8).
13. Syntype, *Dinarites evolutioni* Kittl (1903: pl. 1, fig. 9).
14. Unfigured paratype, *Dinarites tirolitoides* Kittl.
15. Unfigured paratype, *Dinarites evolutioni* Kittl.
16. Plesiotype, *Dinarites laevis*,—Kittl (1903: pl. 1, fig. 1).
17. Plesiotype,—Kittl (1903: pl. 2, fig. 8).
18. Plesiotype, *Dinarites muchianus*,—Kittl (1903: pl. 1, fig. 7).
19. Plesiotype, *Dinarites nudus*,—Kittl (1903: pl. 1, fig. 13).
20. Figured type, *Dinarites tirolitoides* Kittl (1903: pl. 7, fig. 3).
21. Plesiotype,—Kittl (1903: pl. 2, fig. 9).
22. Figured type, *Dinarites multicostatus* Kittl (1903: pl. 3, fig. 3).
23. Unfigured paratype, *Dinarites evolutioni* Kittl.
24. Plesiotype,—Kittl (1903: pl. 2, fig. 11).
25. Plesiotype, *Dinarites laevis*,—Kittl (1903: pl. 3, fig. 11).
26. Plesiotype,—Kittl (1903: pl. 2, fig. 2).
27. Unfigured paratype, *Dinarites tirolitoides* Kittl.
28. Plesiotype, *Dinarites laevis*,—Kittl (1903: pl. 1, fig. 2).
29. Plesiotype,—Kittl (1903: pl. 3, fig. 1).
30. Plesiotype,—Kittl (1903: pl. 2, fig. 10).
31. Plesiotype,—Kittl (1903: pl. 3, fig. 2).
32. Plesiotype, *Dinarites muchianus*,—Kittl (1903: pl. 1, fig. 5).
33. Plesiotype, *Dinarites nudus*,—Kittl (1903: pl. 1, fig. 11).
34. Figured type, *Dinarites tirolitoides* Kittl (1903: pl. 7, fig. 1).
35. Plesiotype, *Dinarites laevis*,—Kittl (1903: pl. 1, fig. 3).
36. Plesiotype, *Dinarites laevis*,—Kittl (1903: pl. 3, fig. 10).
37. Unfigured paratype, *Dinarites evolutioni* Kittl.
38. Plesiotype, *Dinarites muchianus*,—Kittl (1903: pl. 1, fig. 4).

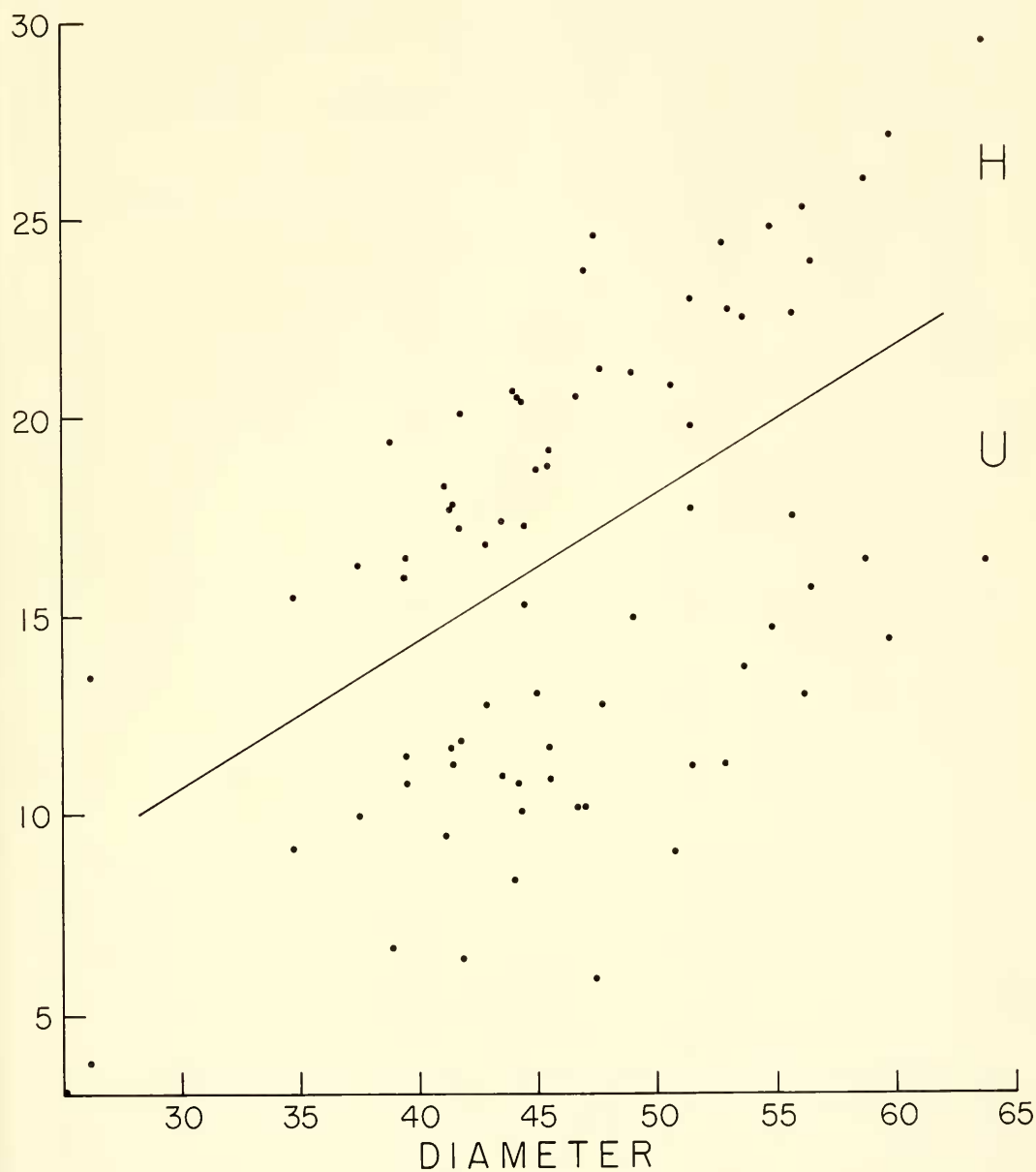


Figure 42. Variation in whorl height (H) and umbilical diameter (U) of *Dinarites dalmatinus* (Hauer), from Werfen Formation, Muć, Dalmatia. The data on this graph are from Table 46.

TABLE 47. MEASUREMENTS OF SPECIMENS OF *DINARITES CARNIOLICUS* (MOJSISOVICS) FROM THE WERFEN FORMATION, DALMATIA, FIGURED BY KITTL (1903). ALL SPECIMENS ARE IN THE NATURAL HISTORY MUSEUM, VIENNA.

	D	W	H	U	W/D	H/D	U/D
1.	59.3	11.7	26.8	11.2	19.7	45.2	19.2
2.	58.5	?	24.6	15.5	?	42.1	26.5
3.	57.2	?	23.0	16.2	?	40.0	28.3
4.	55.2	10.0±	23.2	10.4	18.1±	42.0	18.8
5.	53.3	12.0?	24.2	12.2	22.5?	45.4	22.9
6.	52.7	10.5?	26.2	10.1	19.9	49.7	19.2
7.	52.6	12.0?	23.7?	10.3?	22.8	45.1?	19.6?

1. Plesiotype,—Kittl (1903: pl. 5, fig. 1).
2. Plesiotype,—Kittl (1903: pl. 5, fig. 2).
3. Holotype, *Tirolites heterophanus* Kittl (1903: pl. 5, fig. 7).
4. Syntype, *Tirolites serratlobatus* Kittl (1903: pl. 5, fig. 6).
5. Plesiotype,—Kittl (1903: pl. 5, fig. 3).
6. Syntype, *Tirolites serratlobatus* Kittl (1903: pl. 5, fig. 5).
7. Plesiotype,—Kittl (1903: pl. 5, fig. 4).

Science; plaster casts are in the Museum of Comparative Zoology.

Dinarites carniolicus (Mojsisovics)

Plate 61, figures 1–8

Tirolites carniolicus Mojsisovics, 1882: 65, pl. 1, figs. 2, 3; Kittl, 1903: 35, pl. 5, figs. 1–4; Diener, 1915: 277.

Carniolites carniolicus,—Arthaber, 1911: 241, 250; Spath, 1934: 392, fig. 136; Kummel, in Arkell, et al., 1957: L148, fig. 181,3; Kollárová-Andrusovová, 1962: 31, pl. 2, figs. 6a–c, pl. 3, fig. 4.

Tirolites serratlobatus Kittl, 1903: 36, pl. 5, figs. 5, 6; Arthaber, 1911: 250; Diener, 1915: 279.

Tirolites heterophanus Kittl, 1903: 38, pl. 5, fig. 7; Arthaber, 1911: 250.

This species differs from the “smooth” class of dinaritids merely in the presence of fairly prominent tubercles near the ventral shoulder on the adoral part of the phragmocone and body chamber. I can see no justification for a separation at the generic level. Kittl’s types of the species brought together here as *D. carniolicus* are illustrated here on Plate 61. The measurements of these specimens are shown on Table 47.

Occurrence. The specimens studied here are from the Werfen Formation, Muć, Dal-

matia. The species is also recorded from the same formation in Czechoslovakia (Kollárová-Andrusovová, 1961, 1962).

Repository. The specimens from Muć, studied here, are in the Natural History Museum, Vienna.

Dinarites liatsikasi Renz and Renz

Text-figure 40

Dinarites liatsikasi Renz and Renz, 1947: 60, 75; Renz and Renz, 1948: 49, pl. 1, fig. 3.

Ornamentation and suture (Fig. 40N) differentiate this species from *Dinarites dalmatinus*. The ribbing consists of slightly prosiradiate folds that cross a subtruncate venter. The suture is goniatic but with a very broad first lateral lobe. The holotype measures 35.7 mm in diameter, 11.2 mm for the width of the adoral whorl, 16.2 mm for the height, and 9.8 mm for the diameter of the umbilicus. This species is very similar to *Dinarites undatus* Astakhova from the Mangyshlak Peninsula. In that species the radial ribs are slightly sinuous and are somewhat enlarged at the umbilical shoulder. The suture, likewise, has a much narrower first lateral lobe. There is a superficial similarity in conch form to *Cucoceras* as indicated by Renz and Renz (1948) but the suture is completely different.

Occurrence. *Subcolumbites* fauna, Chios.

Repository. Holotype NHMB J13687, paratypes NHMB J13688.

Dinarites undatus Astakhova

Text-figure 40

Dinarites undatus Astakhova, 1960a: 152, pl. 34, fig. 9, text-fig. 17.

A species of the general design and form of *D. liatsikasi* from the *Subcolumbites* fauna of Chios. The general features are discussed under the discussion of that species. The suture is illustrated on Figure 40M.

Occurrence. *Tirolites* Zone of Astakhova (1960a), Mangyshlak Peninsula.

Genus *Hololobus* (Kittl)**Type species, *Tirolites (Hololobus) monoptychus* Kittl, 1903*****Hololobus monoptychus* (Kittl)****Plate 70, figures 1, 2; Text-figure 40***Tirolites (Hololobus) monoptychus* Kittl, 1903: 33, pl. 4, fig. 9; Diener, 1915: 280.*Hololobus monoptychus*,—Spath, 1934: 390, fig. 135; Kummel, in Arkell, et al., 1957: L148, fig. 181,5.

The type, and only specimen, of this species and genus is of only fair preservation. It measures 61.8 mm in diameter, 15.7 mm for the width of the adoral whorl, 26.7 mm for the height, and the umbilicus is 16.8 mm in diameter. The critical point of interest with this species is the nature of the ventral lobe. Examination of the type specimen clearly shows that Kittl's drawing of the suture (Fig. 40K) is accurate. Like Kittl, I could not observe any trace of a ventral siphuncle, but this I attribute more to faulty preservation than to anything else.

Occurrence. Werfen Formation, Muć, Dalmatia.

Repository. Natural History Museum, Vienna.

Genus *Pseudodinarites* Hyatt**Type species, *Dinarites mohamedanus* Mojsisovics, 1882*****Pseudodinarites mohamedanus* (Mojsisovics)****Plate 57, figures 7–9; Plate 62, figure 6***Dinarites mohamedanus* Mojsisovics, 1882: 7, pl. 40, fig. 12.*Pseudodinarites mohamedanus*,—Hyatt, 1900: 559; Spath, 1934: 387, fig. 133; Kummel, in Arkell et al., 1957: L148.*Dinarites (Hercogovites) mohamedanus*,—Kittl, 1903: 22, pl. 3, figs. 5–7; Diener, 1915: 122.

This species is supposedly characterized by an evolute, smooth conch with rounded but slightly compressed whorls and suture with ceratitic lobes. Mojsisovics' type specimen was not studied; the specimens assigned to this species by Kittl are illustrated

here. These specimens are so poorly preserved they add little to our understanding of this genus or species. The few specimens of this species have all come from the Werfen Formation of the Alps and adjacent regions. Simionescu (1908: 161) recorded a specimen as *Dinarites* cfr. *mohamedanus* from eastern Rumania. This is the only species that has been assigned to this genus. It is quite clear much more data are needed to evaluate the generic relations of the species.

Occurrence. Kittl's specimens illustrated here are from the Werfen Formation, Muć, Dalmatia.

Repository. Kittl's specimens are in the Natural History Museum, Vienna.

Family HELLENITIDAE Kummel, 1952**Genus *Hellenites* Renz and Renz, 1947****Type species, *Tropicellites praematurus* Arthaber, 1911**

Evolute forms with subquadrate whorl section. Lateral sides with rectiradiate to radial ribs which curve adorally on ventral shoulder forming an acute junction with a median ventral keel; ribs may or may not cross keel. Suture with simple pronged ventral lobe, large, denticulated lateral lobe and very simple second lateral lobe, saddles rounded.

This extremely interesting and somewhat anomalous group of late Scythian ammonoids has been the source of an evolving confusion. The group was first recognized by Arthaber (1911) on the basis of two specimens from the *Subcolumbites* fauna of Albania. Neither of these two specimens had the suture preserved, and on the basis of the conch form and ornamentation, he placed them in the genus *Tropicellites*, a common late Triassic (Carnian) group. A more complete understanding of Arthaber's species was not possible until Renz and Renz (1948) described and illustrated a number of conspecific forms from the *Subcolumbites* fauna of Chios. The suture is

well preserved on these Chios specimens and shows that it is very different from the suture of the late Triassic *Tropiceltites*. On this basis, Renz and Renz erected the genus *Hellenites*.

Neither of these authors, however, had taken note of *Pseudharpoceras spiniger* Waagen (1895: 130, pl. 21, fig. 1). This species was based on a single specimen from a horizon Waagen considered to be near the top of his Ceratite formation in the Sheik-Budin Hills of the Trans-Indus Region. Spath (1951: 8) correctly pointed out that the specimens may belong to an Upper Triassic hildoceratid or some other related form.

J. P. Smith (1932) assigned a single specimen from the *Columbites* fauna of southeastern Idaho to the genus *Pseudharpoceras*. Spath (1951: 9) made the claim, and correctly so, that since *Pseudharpoceras* was based on a poorly preserved specimen of uncertain stratigraphic position this genus should be rejected. He then introduced the genus *Pseudarniotites* with *Pseudharpoceras idahoense* Smith (1932: 81, pl. 49, figs. 17–19) as type. Spath was at this time unaware of the genus *Hellenites* Renz and Renz, 1948. *Pseudharpoceras idahoense* is clearly a species of *Hellenites*.

The specimen Waagen described and illustrated as *Pseudharpoceras spiniger* is not in the collections of the Geological Survey of India. There is, however, a partial mold of one side plus a plaster cast. These have been illustrated and discussed by Kummel (1966) and his conclusion was similar to that of Spath: that the genus and species should be rejected.

The *Subcolumbites* fauna of Chios has two species of this genus. One or both of these two species are recognized from the same horizon in Kwangsi, China, from the Primorye Region, eastern Siberia, and the Tobin Formation of Nevada. *Hellenites idahoense* occurs in the *Columbites* fauna of southeastern Idaho.

TABLE 48. MEASUREMENTS OF *HELLENITES PRAEMATURUS* (ARTHABER) FROM *SUBCOLUMBITES* FAUNAS, ALBANIA AND CHIOS.

	D	W	H	U	W/D	H/D	U/D
1.	55.2	13.2	17.7	25.5	23.9	32.1	46.2
2.	53.4	14.3	15.0	29.0	26.6	27.2	54.5
3.	52.3	15.9	16.8	26.2	30.4	32.2	50.1
4.	48.2	12.2	14.0	23.0	25.3	29.1	47.8
5.	47.0?	13.2	14.5?	22.4	28.1?	30.9?	47.6?
6.	46.2	11.7?	13.8	18.6	25.4?	29.9	41.0
7.	44.2	11.6?	14.4	20.5	27.2?	32.6	46.4
8.	43.3	13.0	13.2	21.1	30.0	30.6	48.7
9.	42.1	12.1?	12.8	20.2	28.7?	30.4	47.9?
10.	36.8	10.3	10.5	17.1	28.0	28.5	46.5
11.	36.7	10.7	10.7	17.4	29.2	29.2	47.4
12.	36.3	9.6?	11.9	16.6	26.4?	32.8	45.7
13.	36.2	9.2	10.1	19.2	25.4	27.9	53.0
14.	35.8	10.8	11.0	16.0	30.2	30.7	44.7
15.	34.1	10.7	10.4	14.6?	31.4	30.5	42.8
16.	33.4	10.1	11.1?	14.5	30.2	33.2?	43.4
17.	33.0	9.8	10.9	14.7	29.7	33.0	44.5
18.	25.7	8.0	6.8	13.0	31.1	26.5	50.6
19.	25.7	8.2?	9.1	10.2	31.9?	35.4	39.0
20.	25.5	7.5	7.5	10.8?	29.4	29.4	42.4?
21.	23.3	6.8	7.7	9.6	29.2	33.0	41.2
22.	19.1	7.8?	6.2	8.8	40.8?	32.4	46.0
23.	16.6	6.1	6.0	7.0	36.7	36.1	42.2
24.	13.8	6.3	4.8	5.6?	45.7	34.8	40.6?

1. Syntype, *H. praematurus* var. *aegacica* Renz and Renz (1947: 60; 1948, pl. 2, fig. 6), NHMB J13664.
2. Holotype, *H. trikkalinoi* Renz and Renz (1947: 60, 75; 1948, pl. 2, fig. 2), NHMB J13668.
3. 9, 15, 18, 24. Unfigured paratypes, *H. trikkalinoi*, Maradovuno, Chios, NHMB J13672.
4. 23. Unfigured paratypes, Kephavouno, Chios, NHMB J13673.
5. Syntype, *H. praematurus* var. *aegacica* Renz and Renz (1947: 60; 1948, pl. 2, fig. 8), NHMB J13665.
6. 10, 14, 16, 17, 20, 21. Unfigured paratypes, Maradovuno, Chios, NHMB J13662.
7. Type specimen, *H. trikkalinoi* var. *gracca* Renz and Renz (1947: 60; 1948, pl. 2, fig. 5), NHMB J13674.
8. Plesiotype,—Renz and Renz (1948: pl. 2, fig. 7), NHMB J13660.
11. Plesiotype,—Renz and Renz (1948: pl. 2, fig. 3), NHMB J13661.
12. Syntype, *H. praematurus* var. *aegacica* Renz and Renz (1947: 60; 1948, pl. 2, fig. 9), NHMB J13667.
13. Paratype, *H. trikkalinoi* Renz and Renz (1948: pl. 2, fig. 4), NHMB J13671.
19. Holotype, *H. praematurus* (Arthaber, 1911: pl. 24 (8), figs. 9a, b), PIUV.
22. Holotype, *H. praematurus* var. (Arthaber, 1911: pl. 24(8), figs. 10a, b), PIUV.

Hellenites praematurus (Arthaber)

Plate 7, figures 1–4; Text-figure 43

- Tropiceltites praematurus* Arthaber, 1911: 268, pl. 24(8), figs. 9a, b; C. Renz, 1928: 155.
Tropiceltites ? *praematurus* var. Arthaber, 1911: 269, pl. 24(8), figs. 10a, b.
Tropiceltites (?) *praematurus*,—Diener, 1915: 300.

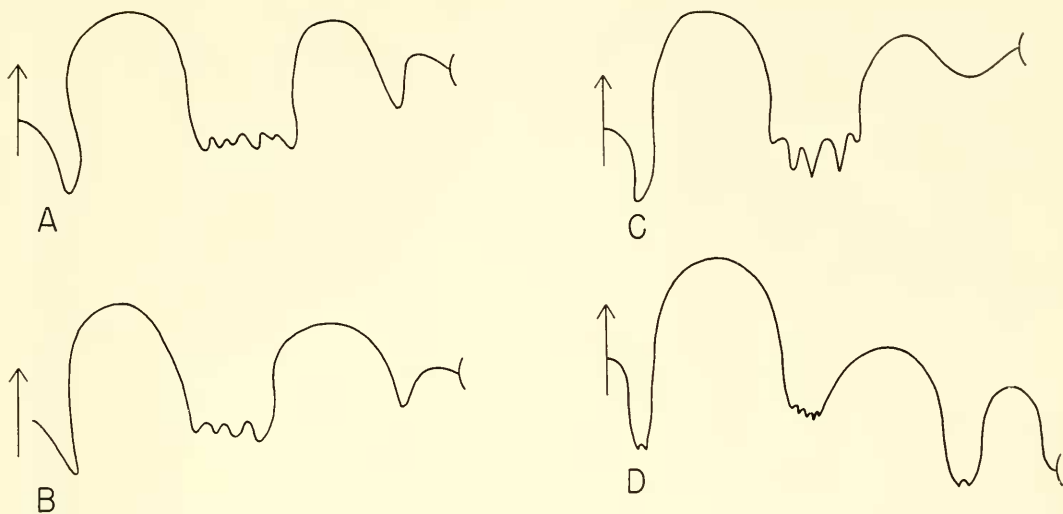


Figure 43. Diagrammatic representation of the suture of: A, *Hellenites trikkalinoi* Renz and Renz (1948: pl. 2, fig. 2b), at a diameter of 35 mm; B, *H. praematurus* (Arthaber),—Renz and Renz (1948: pl. 2, fig. 8b), at a diameter of 30 mm; C, *H. radiatus* Renz and Renz (1948: pl. 2, fig. 13b), at a diameter of 20 mm; D, *H. idahaense* (Smith) (USNM 74994), at a diameter of 13 mm.

Specimens of figures A–C from *Subcolumbites* fauna, Chios; specimen of figure D from *Columbites* fauna of southeast Idaho.

Hellenites praematurus,—Renz and Renz, 1947: 60, 75; Renz and Renz, 1948: 44, pl. 2, figs. 3–3a, 7–7a; Kummel, in Arkell et al., 1957: L149, figs. 181, 6a–c.

Hellenites praematurus var. *aegaeica* Renz and Renz, 1947: 60; Renz and Renz, 1948: 45, pl. 2, figs. 6–6b, 8–8b, 9–9a.

Hellenites trikkalinoi Renz and Renz, 1947: 60, 75; Renz and Renz, 1948: 46, pl. 2, figs. 1–1a, 2–2b, 4–4b.

Hellenites trikkalinoi var. *gracca* Renz and Renz, 1947: 60; Renz and Renz, 1948: 46, pl. 2, figs. 5–5b.

Hellenites cf. *praematurus*,—Chao, 1959: 145, pl. 41, figs. 1, 2 (not 3, 4).

This species was established by Arthaber on the basis of two specimens, one of which he considered to be a variety. The preservation of both of these specimens leaves much to be desired. The measurements are as follows:

D	W	H	U	W/D	H/D	U/D
25.7	8.2?	9.1	10.2	31.9?	35.4	39.7

Holotype—Arthaber, 1911: pl. 24(8), fig. 9a, b.

19.1	7.8?	6.2	8.8	40.8?	32.5	46.1
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Paratype—Arthaber, 1911: pl. 24(8), fig. 10 a, b.

The suture is not preserved on either of these specimens.

This anomalous late Scythian species remained somewhat of a problem until the discovery of the contemporaneous *Subcolumbites* fauna from Chios. A number of specimens of *H. praematurus* have been well illustrated by Renz and Renz (1948). In addition to *H. praematurus*, these authors recognized a variety and another species based mainly on the relative prominence of the ribs. It is apparent on examination of the large number of specimens in the fauna studied by Renz and Renz that there is wide variation in rib prominence, and that there are gradational forms connecting the species and varieties recognized. In the other morphological features, as width, height and umbilical diameter, there is relatively little variation (see Table 48 and Figure 44). The sutures are illustrated on Figures 43 A, B.

Chao (1959) obtained two fragmentary

specimens from separate localities of the *Subcolumbites* horizon, which he described as *H. cf. praematurus*. One of these specimens (Chao, 1959: pl. 41, figs. 1, 2) is identical in rib pattern, conch shape, etc., to *H. praematurus*. Though a suture is not preserved on this specimen, I believe it to be a valid representative of *H. praematurus*. The second specimen is more fragmentary and of poorer preservation. The rib pattern, however, compares favorably with *H. radiatus*.

Occurrence. *Subcolumbites* faunas of Albania, Chios, and Kwangsi, China (Chao collections 542a, 546).

Repository. Holotype and paratype, in the Paleontological Institute, Vienna; specimens from Chios, plesiotypes, Renz and Renz (1948: pl. 2, figs. 3-3a) NHMB J13661, (1948: pl. 2, figs. 7-7a) NHMB J13660; unfigured specimens from Maradovuno NHMB J13662; unfigured specimens from Kephlovuno NHMB J13663; type specimens, *H. praematurus* var. *aegaeica* Renz and Renz (1948: pl. 2, fig. 6) NHMB J13664, (pl. 2, figs. 8-8a) NHMB J13665, (pl. 2, fig. 8b) NHMB J13666, (pl. 2, fig. 9) NHMB J13667; holotype *H. trikkalinoi* Renz and Renz (1948: pl. 2, fig. 2-2a) NHMB J13668; paratypes, Renz and Renz (1948: pl. 2, fig. 1) NHMB J13670, (pl. 2, fig. 4) NHMB J13671, (pl. 2, fig. 2b) NHMB J13669; unfigured paratypes from Maradovuno NHMB J13672, from Kephlovuno NHMB J13673; type specimen *H. trikkalinoi* var. *graeca* Renz and Renz (1948: pl. 2, fig. 5) NHMB J13674.

Hellenites radiatus Renz and Renz

Text-figure 43

Hellenites (Pallasites) radiatus Renz and Renz, 1947: 60, 75; Renz and Renz, 1948: 47, pl. 2, figs. 12-12b, 13-13b.

Hellenites (Pallasites) striatus Renz and Renz, 1947: 60, 75; Renz and Renz, 1948: 47, pl. 2, figs. 11-11a.

Hellenites (Pallasites) striatus var. *densicostata* Renz and Renz, 1947: 60, 75; Renz and Renz, 1948: 48, pl. 2, figs. 10-10b.

Hellenites cf. praematurus Chao, 1959: 145, pl. 41, figs. 3, 4 (not 1 and 2).

TABLE 49. MEASUREMENTS OF *HELLENITES RADIATUS* RENZ AND RENZ FROM THE *SUBCOLUMBITES* FAUNA OF CHIOS.

	D	W	H	U	W/D	H/D	U/D
1.	43.7	10.9	13.5	20.5	24.9	30.9	46.9
2.	37.1	10.5	12.7	15.7	28.3	34.2	42.3
3.	33.4?	8.5	11.7	8.2	25.4?	35.0?	24.6?
4.	31.2	8.5	10.1	14.1	27.2	32.4	45.2
5.	30.2	7.2	8.7	14.7	23.8	28.8	48.7
6.	29.5	8.5	9.8	12.6	28.8	33.2	42.7
7.	28.7	8.2	10.0	12.5	28.6	34.8	43.6
8.	27.8?	7.0	8.3	13.2	25.2?	29.9?	47.5?
9.	26.7	6.1	7.8	12.7	22.8	29.2	47.6
10.	22.8	5.4	7.4	10.3	23.7	32.5	45.2
11.	22.3	6.8	6.4	10.1	30.5	28.7	45.3
12.	17.8	5.1?	5.5	8.5	28.7?	30.9	47.8

1, 2. Unfigured paratypes, Maradovuno, Chios, NHMB J13678.

3. Holotype, *H. (Pallasites) striatus* var. *densicostata* Renz and Renz (1947: 60, 75; 1948: pl. 2, fig. 10), NHMB J13681.

4. Paratype, Renz and Renz (1947: 60, 75; 1948, pl. 2, fig. 13), NHMB J13677.

5, 6, 11, 12. Unfigured paratypes, *H. (Pallasites) striatus*, Maradovuno, Chios, NHMB J13680.

7. Holotype, Renz and Renz (1947: 60, 75; 1948: pl. 2, fig. 12), NHMB J13675.

8. Holotype, *H. (Pallasites) striatus* Renz and Renz (1947: 60, 75; 1948: pl. 2, fig. 11), NHMB J13679.

9, 10. Unfigured paratypes, *H. (Pallasites) striatus* var. *densicostata*, Maradovuno, Chios, NHMB J13682.

This species is exactly like *H. praematurus* except that the ribs are radial instead of rursiradiate. Renz and Renz (1948) distinguished within this group two species under a separate subgenus of *Hellenites*. The two species were separated on the basis of rib prominence, but again the collections have a number of transitional forms in this character. The suture (Fig. 43H) is essentially the same as in *H. praematurus*.

The only distinguishing feature between *H. praematurus* and *H. radiatus* is the character of the lateral ribs. This is presumably a valid species criterion but not one to warrant erection of a separate subgenus.

This species is not as abundant in the Chios fauna as *H. praematurus*. As in the latter species, *H. radiatus* does not exhibit any marked variability in the basic conch dimensions. On Table 49 are measurements of 12 specimens including the primary

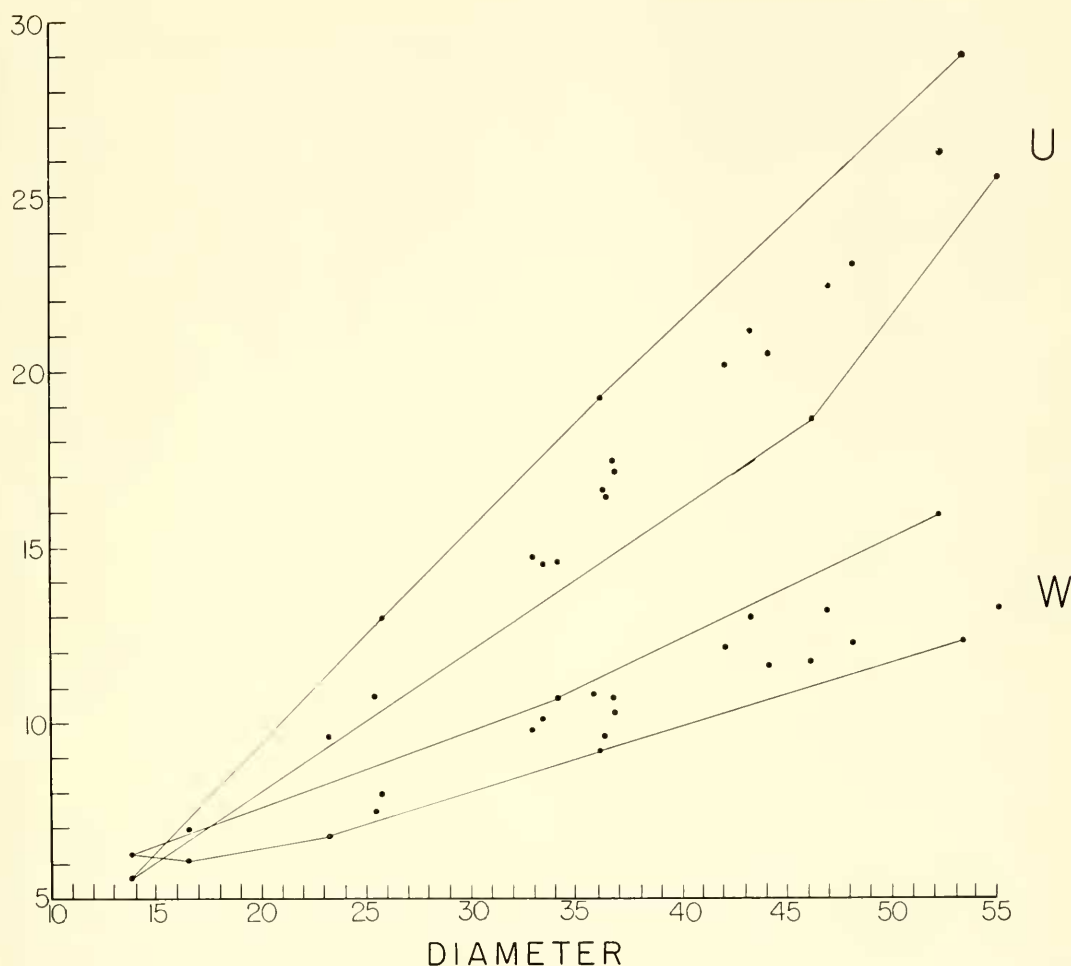


Figure 44. Variation in whorl width (W) and umbilical diameter (U) of *Hellenites praematurus* (Arthaber), from the *Subcolumbites* fauna of Albania and Chios. The data on this graph are from Table 48.

types. The measurements are plotted on Figure 44.

One of the specimens from a *Subcolumbites* horizon in Kwangsi, China, that Chao (1959: pl. 41, figs. 3, 4) assigned to *H. cf. praematurus* has radial ribs and should be assigned to *H. radiatus*. The specimen is poorly preserved and lacks a suture, but the pattern of ornamentation, etc., is so distinctive that this conclusion seems justified.

The Tobin Formation of Nevada has yielded one specimen, 18 mm in diameter, that appears to be identical to the other

representatives of this species. No suture is preserved, but the degree of involution, ornamentation, etc., are identical.

The species of *Hellenites* from Chios and Kwangsi are from *Subcolumbites* faunas. There are two older species which need to be attached to this genus. These are *H. idahoense* (Smith, 1932: 81, pl. 49, figs. 13–19) from the *Columbites* fauna of southeastern Idaho, and *H. inopinatus* Kiparissova (1958a) from the Primorye Region at a horizon equivalent to the *Columbites* Zone of Idaho.

Occurrence. The holotype and paratype from the *Subcolumbites* fauna of Chios; from *Subcolumbites* fauna, Naliling, one kilometer northeast of Lolou, Lingolo district, Kwangsi, China; upper part of Tobin Formation, south end of Tobin Range, Nevada.

Repository. Holotype, Renz and Renz (1948: pl. 2, figs. 12–12a) NHMB J13675; paratypes, Renz and Renz (1948: pl. 2, fig. 12b) NHMB J13676, (pl. 2, figs. 13–13b) NHMB J13677; unfigured paratypes from Maradovuno NHMB J13678; holotype, *H. (Pallasites) striatus* Renz and Renz (1948: pl. 2, figs. 11–11a) NHMB J13679; unfigured paratypes NHMB J13680; type specimens *H. (Pallasites) striatus* var. *densicostata* Renz and Renz (1948: pl. 2, figs. 10–10b) NHMB J13681; unfigured paratypes NHMB J13682; specimen from Tobin Formation MCZ 9654.

Hellenites idahoense (Smith)

Plate 53, figures 13, 14; Text-figure 43

Pseudharpoceras idahoense Smith, 1932: 81, pl. 49, figs. 17–19.

Pseudarniotites idahoense,—Spath, 1951: 9.

Smith based his species on a small fragmentary specimen 19 mm in diameter, and extensive collecting from the same horizon in southeastern Idaho has not yielded any additional specimens. This species is very similar in its basic morphological features to *H. radiatus*. The differences are mainly seen in the character of the ribs on the venter, the character of the keel, and the suture (Fig. 43D).

Most other occurrences of *Hellenites* are from *Subcolumbites* faunas of latest Scythian age. This species is from the *Columbites* Zone.

Occurrence. Middle shale member, Thaynes Formation, *Columbites* Zone, Paris Canyon, southeastern Idaho.

Repository. Holotype, USNM 74994.

Hellenites inopinatus Kiparisova

Hellenites (?) *inopinatus* Kiparisova, 1958a: 13, fig. 9; Kiparisova, 1961: 169, pl. 33, fig. 4.

Kiparisova had six specimens upon which to base her species, but unfortunately none of these yielded a suture, nor was the preservation of the specimens particularly good. On the basis of the illustrations and figures of the holotype, this species is quite similar to *H. radiatus* Renz and Renz from the *Subcolumbites* fauna of Chios. Kiparisova (1961) did not give precise stratigraphic data on her species, but Zakharov (personal communication) tells me that the species is in his *Neocolumbites insignis* Subzone which is correlative with the *Columbites* fauna of southeast Idaho. Kiparisova's species is not very similar to *Hellenites idahoense* (Smith) from the *Columbites* fauna of southeast Idaho.

Occurrence. *Neocolumbites insignis* Subzone, Primorye Region.

Family BEYRICHTIDAE Spath, 1934

Genus *Beyrichites* Waagen, 1895

Type species, *Ammonites reuttensis* Beyrich, 1867

Beyrichites laurae Renz and Renz

Text-figure 45

Beyrichites laurae Renz and Renz, 1948: 62, pl. 8, fig. 1.

Beyrichites praematurus Renz and Renz, 1948: 61, pl. 7, fig. 5.

The authors of this species were fully cognizant that the presence of this typical Anisian genus in their Chios fauna raised serious questions. They briefly discussed the possibility of mixing and reworking versus the true existence of this genus in the late Scythian. On the basis of the data available, I have elected to accept this species as a member of the late Scythian Chios fauna. Each of the two species of this genus recognized by Renz and Renz was based on a single specimen; I can see no significant difference between these two specimens.

Occurrence. *Subcolumbites* fauna of Chios.

Repository. Holotype of *Beyrichites laurae*, NHMB J13712, holotype of *B. praematurus*, NHMB J13711.

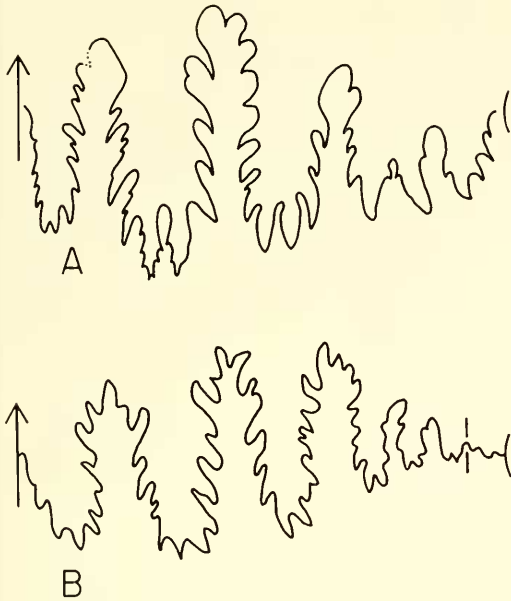


Figure 45. Diagrammatic representation of the suture of: A, *Eogymnites arthaberi* (Diener), from holotype, at a diameter of 75 mm, from *Subcolumbites* fauna of Albania; B, *Beyrichites lauræ* Renz and Renz (1948: pl. 8, fig. 1b), at a diameter of 42 mm, from *Subcolumbites* fauna of Chios (NHMB J13712).

Superfamily PINACOCERATACEAE Mojsisovics, 1879

Family GYMNITIDAE Waagen, 1895

Genus *Eogymnites* Spath, 1951

Type species, *Japonites arthaberi* Diener, 1915

***Eogymnites arthaberi* (Diener)**

Plate 21, figures 1, 2; Text-figure 45

Japonites sugriva Diener var. *Arthaber*, 1911: 231, pl. 20(4), fig. 4.

Japonites arthaberi Diener, 1915: 158 (= *J. sugriva*,—*Arthaber* non Diener); Kummel, in Arkell et al., 1957: L185, fig. 214,4.

Japonites decipiens Spath, 1951: 172 (= *J. sugriva*,—*Arthaber* non Diener).

Arthaber's type and only specimen of this unusual Scythian species is only modestly well preserved, consisting mainly of phragmocone; the adoral 30 mm is body chamber. The specimen measures approximately 89 mm in diameter, 23.4 mm for the width of the adoral whorl, 29 mm for the

height, and 36.4 mm for the diameter of the umbilicus. The whorls are compressed with convex whorl sides converging to a narrowly rounded venter. The maximum width is at the umbilical shoulder. The umbilical wall is low, rounded, and slopes to the umbilical seam at a steep angle. The shell is preserved only in part, and very poorly; it is apparently smooth except for slightly sinuous growth lines.

Spath (1951: 172) expressed concern over *Arthaber's* (1911: pl. 20(4), fig. 4c) illustration of the suture. A new drawing made from the type specimen is illustrated here on Figure 45A. As with nearly all the specimens from the *Subcolumbites* fauna from Albania and Chios, the suture can be developed only by grinding. The suture illustrated here I believe to be a fairly accurate representation and does not differ from that reproduced by *Arthaber* to any significant degree.

There is no other Scythian ammonoid comparable to this species.

Occurrence. *Subcolumbites* fauna, Këçira, Albania.

Repository. Paleontological Institute, University of Vienna.

Family HUNGARITIDAE Waagen, 1895

Genus *Prohungarites* Spath, 1934

Type species, *Prohungarites similis* Spath (= *Hungarites* cf. *middlemissii* Diener,—Welter, 1922)

***Prohungarites crasseplicatus* (Welter)**

Text-figure 46

Hungarites crasseplicatus Welter, 1922: 147, pl. 168(14), figs. 1–6.

Prohungarites crasseplicatus,—Spath, 1934: 244; Spath, 1951: 20; Kummel, 1961: 525.

Hungarites cf. *middlemissii* Diener,—Welter, 1922: 146, pl. 13, figs. 6–9, 18.

Prohungarites similis Spath, 1934: 327; Spath, 1951: 19; Kummel, in Arkell et al., 1957: L155, fig. 186,7.

It was for this morphologic group from Timor that Spath (1934) introduced the genus *Prohungarites*. Welter (1922) had included in the genus *Hungarites* three

species from the blocks with manganese coated fossils from Nifoekoko, Timor; these were cf. *middlemissii* Diener, *crasseplicatus* and *tuberculatus*. Spath (1934: 327) introduced the species name *similis* for cf. *middlemissii*,—Welter (non Diener). The first two of these species are combined here. They were originally separated merely on differences in the intensity of the ribbing. Even Welter (1922: 147) discussed the gradational aspects of the species and illustrated one specimen (Welter, 1922: pl. 167(13), figs. 10, 11) as a transitional form between *P. middlemissii* and *P. crasseplicatus*. Restudy of Welter's types show that his descriptions and illustrations are quite adequate. The measurements of Welter's types are as follows:

	D	W	H	U	W/D	H/D	U/D
1.	58.5	17.5	23.4	15.1	29.9	40.0	25.8
2.	38.7	14.2	16.5	10.6	36.7	42.6	27.4
3.	36.1	11.5	15.0	10.5	31.9	41.6	29.1
4.	35.4	11.4	16.0?	8.2?	32.2	45.2?	23.2?
5.	33.6	11.9	13.2	11.2	35.4	39.3	33.3
6.	30.0	10.1	11.9	9.5	33.7	39.7	31.7

1. Welter (1922: pl. 13, figs. 6–9) GPIBo 226a.
2. Welter (1922: pl. 14, figs. 1–3) GPIBo 228a.
3. Welter (1922: pl. 13, figs. 10–11) GPIBo 227.
4. Welter (1922: pl. 13, fig. 18) GPIBo 226b.
5. Welter (1922: pl. 14, figs. 4, 5) GPIBo 228b.
6. Welter (1922: pl. 14, fig. 6) GPIBo 228c.

The upper part of the Thaynes Formation along Hammond Creek in southeastern Idaho has yielded about 30 poorly preserved specimens which are very similar to the Timor *P. crasseplicatus*. The whorls of the Idaho species are fastigate only on the early volutions. The mature volutions have rounded venters. The slightly sinuous ribs on most of the specimens are comparable to those on Welter's transitional specimen between *P. similis* and *P. crasseplicatus* but are prosiradiate, not radial. The largest specimen, approximately 65 mm in diameter, consisting of a half volution of body chamber, has the blunt lateral ribs like Welter's *P. crasseplicatus* (Welter, 1922: pl. 14, figs. 1–3). The sutures in the Timor and Idaho specimens are likewise similar (Fig. 46).

Occurrence. The specimens from Timor came from the limestone with manganese coated fossils, Nifoekoko.

Repository. Holotype *P. similis* Spath (= *Hungarites* cf. *middlemissii*,—Welter, 1922: pl. 13, figs. 6–9) GPIBo 226a; paratype, *Hungarites* cf. *middlemissii*,—Welter (1922: pl. 13, fig. 18) GPIBo 226b; syntype *P. crasseplicatus* (Welter, 1922: pl. 14, figs. 1–3) GPIBo 228a, (pl. 14, figs. 4, 5) GPIBo 228b, (pl. 14, fig. 6) GPIBo 228c; Welter's transitional specimen (1922: pl. 13, figs. 10, 11) GPIBo 227.

Prohungarites cf. *crasseplicatus* (Welter)

Prohungarites cf. *crasseplicatus*,—Kummel, 1966: 400, pl. 3, figs. 11, 12.

Four small phragmocones from West Pakistan differ from the Timor *P. crasseplicatus* principally in the absence of any indication of a keel along the central part of the venter on the mature whorls. In all other conch features, such as shape of the whorl section, shape of the ventral and umbilical shoulders, and nature of the umbilical wall, it is very similar. The suture is likewise essentially the same. The other Timor species, *Prohungarites tuberculatus*, is more robust with a more highly developed ornamental pattern. There is a strong morphological similarity to *Prohungarites gutstadtii* n. sp. from the Upper Thaynes Formation of southeast Idaho. Both species have acute venters only on the earliest volutions and rounded venters on the later volutions.

Occurrence. Narmia Member of the Mianwali Formation, Narmia Nala, Surghar Range, West Pakistan.

Repository. MCZ 9606, 9607.

Prohungarites tuberculatus (Welter)

Text-figure 46

Hungarites tuberculatus Welter, 1922: 148, pl. 167(13), figs. 12–17.

Prohungarites tuberculatus,—Spath, 1934: 244; Kummel, 1961: 525.

The basic form of the conch in this species is very much like *P. crasseplicatus*

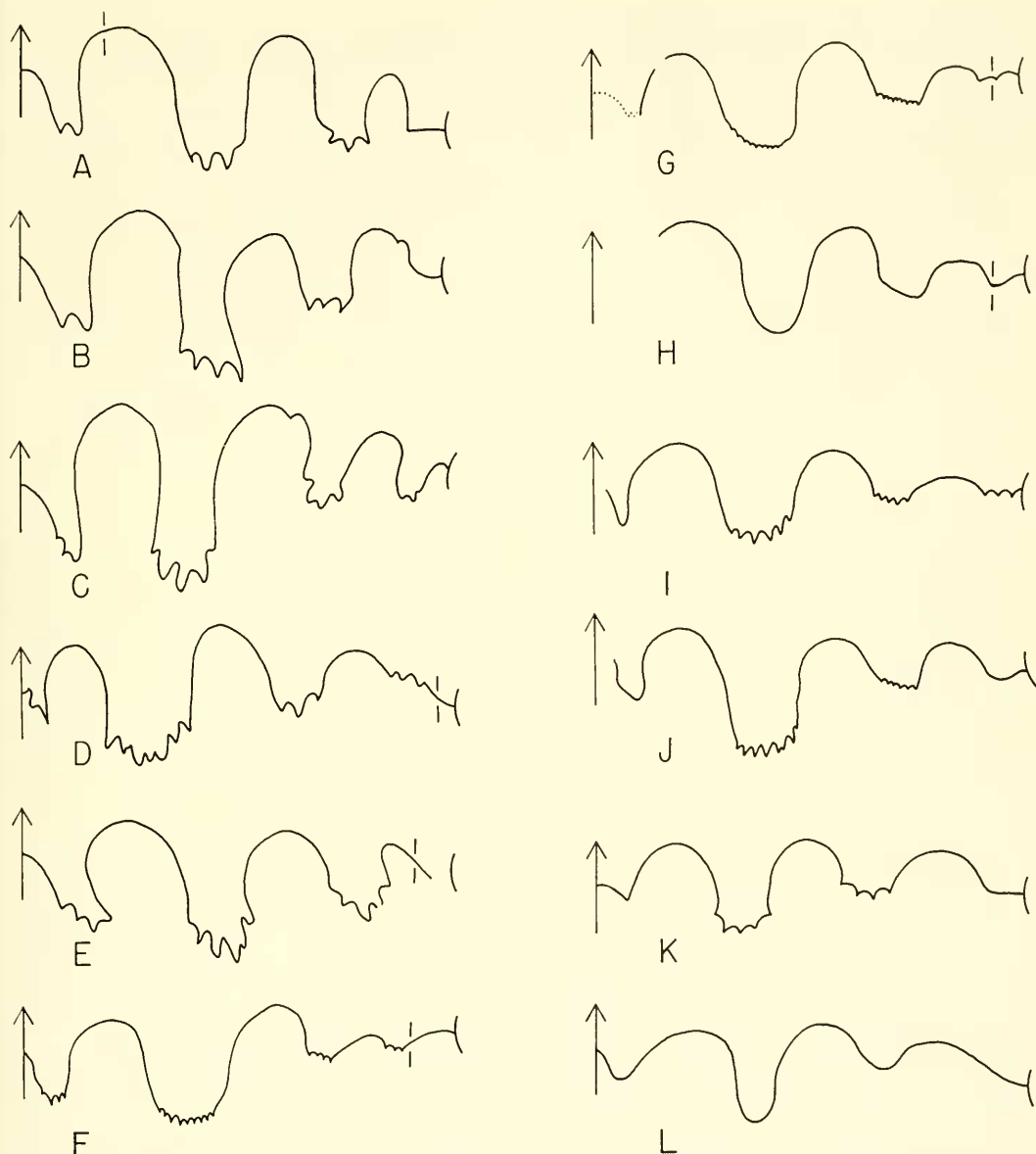


Figure 46. Diagrammatic representation of the suture of: A, *Hungarites* cf. *middlemissii* Diener,—Welter (1922: pl. 13, fig. 18), from Block E, Nifoekoko, Timor; B, *Hungarites crasseplicatus* Welter (1922: pl. 14, fig. 6), from Block E, Nifoekoko, Timor; C, *Hungarites tuberculatus* Welter (1922: pl. 13, fig. 12), from Block E, Nifoekoko, Timor; D, *Kiparisovites carinatus* Astakhova [1964: 379, fig. 1d], from *Doricranites* Zone of Astakhova, Mangyshlak Peninsula; E, *Prohungarites* (?) *popovi* Kiparisova (1961: fig. 113), from Anisian strata of the Primorye Region, at a whorl height of 13 mm; F, *Prohungarites mckelveyi* n. sp. from Upper Thaynes Formation, Hammond Creek, southeast Idaho, at a whorl height of 17 mm (MCZ 9646); G, *Prohungarites gutstadtii* n. sp., from Upper Thaynes Formation, Hammond Creek, southeast Idaho, at a whorl height of 13 mm (holotype MCZ 9475); H, *Prohungarites* sp. indet., from Upper Thaynes Formation, Hammond Creek, southeast Idaho, at a whorl height of 15 mm (MCZ 9648); I, *Prohungarites* sp. indet., from Upper Thaynes Formation, Hammond Creek, southeast Idaho, at a whorl height of 26 mm; J, *Dalmatites marlaccus* Kittl (1903: pl. 4, fig. 6), from Werfen Formation, Dalmatia; K, *Dalmatites kittli* n. sp., from *Columbites* Zone, Paris Canyon, southeast Idaho, at a whorl height of 10 mm (MCZ 9499).

except that it is more evolute and the whorls more inflated. The big difference in these species is in the ornamentation. This species has coarse, conspicuous ribs with a node just above the umbilical shoulder. This pattern of ornamentation commences at an early growth stage, as can be seen in the umbilical region of Welter's holotype and in the small specimen illustrated by Welter (1922: pl. 13, figs. 16, 17). The measurements of Welter's two specimens are as follows:

D	W	H	U	W/D	H/D	U/D
47.5	16.6	18.0	17.5	34.9	37.9	36.8
7.3	?	2.5	2.8	?	34.2	38.4

The first of these measurements is for the holotype and the second is for the paratype.

The suture is illustrated on Figure 46C.

Occurrence. In the limestone with black manganese coated fossils, Nifoekoko, Block E, Timor.

Repository. Holotype GPIBo 229a; paratype GPIBo 229b.

Prohungarites middlemissii (Diener)

Plate 25, figures 3–8

Hungarites middlemissii Diener, 1913: 23, pl. 3, figs. 5–7; Diener, 1915: 153; Spath, 1934: 33. *Prohungarites middlemissii*,—Kummel, 1961: 525.

Diener (1913) stated he had approximately 40 specimens of this species collected from a loose block at Pastannah, Kashmir. Of these only the three figured syntypes (Diener, 1913: pl. 3, figs. 5–7) are preserved in the collection of the Geological Survey of India. The disposition of the other specimens is not known.

Even though the suture is unknown, the general conch morphology clearly indicates that this is a valid species of *Prohungarites*. In the degree of involutions and ornamentations, it is quite similar to *P. mckelveyi* but is unique in the widening of the ventral part of the whorl in the mature stages and in the acquisition of nodes on the ribs. *Prohungarites crasseplicatus* has a much more robust whorl section, is more evolute,

and has more pronounced ornamentation. This species strongly suggests the presence of a horizon younger than the *Hedenstroemia* beds in Kashmir. Final evaluation on the biologic affinities of this species and its stratigraphic position will have to await new field investigations and collections.

Occurrence. Loose block, Pastannah, Kashmir.

Repository. Syntype (Diener, 1913: pl. 3, fig. 5) GSI 11276, (pl. 3, fig. 6) GSI 11277, (pl. 3, fig. 7), GSI 11278.

Prohungarites carinatus (Astakhova)

Text-figure 46

Kiparisovites carinatus Astakhova, 1964: 379, pl. 1, fig. 1.

This is clearly a species of *Prohungarites* of the general form of *P. mckelveyi* and *P. crasseplicatus*; just why its author introduced a new genus for her two fragmentary specimens is hard to tell. The suture is shown on Figure 46D.

Occurrence. *Doricranites* Zone (of Astakhova, 1960a, b), Mangyshlak Peninsula, Karatauchik Range.

Prohungarites mckelveyi n. sp.

Plate 35, figures 1–5, 8, 9; Text-figure 46

Prohungarites n. sp. cf. *P. similis*,—Kummel, 1954: 187.

This is the most common species in the upper member of the Thaynes Formation at Hammond Creek, Bear River Range, southeast Idaho. The collection contains a couple of hundred specimens, most of which, however, are not well preserved. In addition, the Tobin Formation, Tobin Range, Nevada, has yielded 10 fragmentary and poorly preserved specimens.

The conch is involute, compressed, with a distinct knife-edged venter. A remarkable feature of this species is the high degree of constancy in basic conch proportions. The venter has a distinct fastigate appearance except that the ventral shoulders are

rounded and not angular. The lateral areas are broadly convex. The umbilical shoulder is acutely rounded and the umbilical wall is vertical.

The conch is essentially smooth, except for extremely faint, moderately spaced, falcoid ribs. Within the small umbilicus only the umbilical shoulders and wall of the preceding volutions are visible. No ornamentation of any kind is visible in the umbilical area.

The suture is shown on Figure 46F.

This new Idaho species displays some morphological similarity to *Prohungarites crasseplicatus* from the manganese coated beds of Nifoekoko, Timor, but a more marked similarity to *Prohungarites middlemissii* from an unknown horizon in Kashmir. The Timor species (*P. crasseplicatus*) is more inflated, more evolute, with sharper ventral shoulders, and with a tendency towards more robust ornamentation. In spite of these differences, the morphological relationships of *P. mckelveyi* and *P. crasseplicatus* are very close. The Kashmir species (*P. middlemissii*) differs mainly in that on the outer volutions the greatest width of the whorls shifts to the region of the ventral shoulders. The degree of involution, the subdued falcoid ribs, and nature of the venter are strikingly similar to *P. mckelveyi*. My specimens from the Tobin Formation, though poorly preserved and fragmentary, cannot be separated from the Idaho forms. N. J. Silberling of the U.S. Geological Survey has kindly shown the author some specimens of *Prohungarites* he collected from the lower part of the Tobin Formation, Tobin Range, Nevada (U.S.G.S. locality 2565). These specimens are very much like the species described here but are slightly more inflated in whorl section; they possibly represent a new species.

Occurrence. Upper member of Thaynes Formation, Hammond Creek, Bear River Range, southeast Idaho; upper part Tobin Formation, Tobin Range, Nevada.

Repository. Specimens from Hammond

Creek: Holotype MCZ 9466 (Pl. 35, figs. 1, 2); figured paratypes MCZ 9467 (Pl. 35, fig. 3, 4), MCZ 9468 (Pl. 35, fig. 5), MCZ 9469 (Pl. 35, figs. 8, 9); unfigured paratypes MCZ 9646; unfigured specimens from Tobin Formation, MCZ 9651.

Prohungarites gutstadtii n. sp.

Plate 36, figures 3, 14, 15; Text-figure 46

Prohungarites cf. *crasseplicatus* Kummel, 1954: 187; Kummel, 1966: 400.

This species is represented by 30 or more specimens most of which, unfortunately, are poorly preserved. This species has the general conch form of *P. crasseplicatus*. It differs in that the venter on the mature volutions is rounded and not fastigate. A blunt sharpened venter is present up to a diameter of approximately 15 mm, as seen in the specimen of Plate 36, figures 14, 15, but at some stage after that the venter becomes rounded. The second major difference is that the ribs are prosiradiate and not radial. The range of ribbing pattern is much the same in the two species. The suture is shown on Figure 46G.

This species is remarkably similar to the specimens assigned to *Prohungarites* cf. *crasseplicatus* from the Narmia Member of the Mianwali Formation in the Surghar Range of West Pakistan (Kummel, 1966). In that species the sharpened venter likewise is confined to the earlier volutions, the more mature volutions having a rounded venter. The ribs in the Pakistan species are radial rather than prosiradiate. The restriction of the sharpened venter to the earliest volutions differentiates these two species from all others assigned to *Prohungarites*.

Occurrence. Upper Thaynes Formation, Hammond Creek, Bear River Range, southeast Idaho.

Repository. Holotype MCZ 9475 (Pl. 36, fig. 3); figured paratype MCZ 9481 (Pl. 36, figs. 14, 15); unfigured paratypes MCZ 9645.

Prohungarites sp. indet.

Plate 38, figures 4, 5; Text-figure 46

The collections from the Hammond Creek locality of the Thaynes Formation, and from the upper part of the Tobin Formation in the Tobin Range, Nevada, contain, in association with *Prohungarites mckelveyi*, several poorly preserved fragments that are clearly a new and distinctive species of ammonite. However, because of the fragmentary nature of the specimens no new name is introduced. The whorls are very rapidly expanding with radial to slightly prosiradiate ribs that are greatly enlarged in the general region of the umbilical shoulder. The venter is fairly broad and fastigate. The suture is shown on Figure 46H, I.

This form is completely different from the associated *Prohungarites mckelveyi* and *Prohungarites gutstadtii* and is quite different from the other species of *Prohungarites* reported to date. The pattern of ribbing and the rapidly expanding whorls at first suggested a relationship to *Arctoprionites*. In that genus, however, in so far as we know, the venter is truncate and never fastigate. The suture of the form recorded here is more *prohungaritid* in aspect.

Occurrence. Upper Thaynes Formation, Hammond Creek, Bear River Range, southeast Idaho; upper Tobin Formation, south end Tobin Range, Nevada.

Repository. Figured specimens from southeast Idaho MCZ 9474 (Pl. 36, figs. 1, 2), MCZ 9647 (Pl. 38, figs. 4, 5); unfigured specimens from southeast Idaho MCZ 9648; specimens from Tobin Range MCZ 9652.

Genus *Dalmatites* Kittl, 1903

Type species, *Dalmatites morlaccus* Kittl, 1903

Dalmatites morlaccus Kittl

Plate 56, figures 1-8; Text-figure 46

Dalmatites morlaccus Kittl, 1903: 73, pl. 4, figs. 3-7; Diener, 1915: 115; Spath, 1951: 20; Kummel, in Arkell, et al., 1957: L156, fig. 187, 7.

The four specimens of this species illustrated by Kittl (1903: pl. 4, figs. 4-7) are still preserved. The photographs of these type specimens reproduced here on Plate 56 show that the preservation is no more than fair to poor. The measurements of these four specimens are as follows:

	D	W	H	U	W/D	H/D	U/D
1.	69.0	15.6	39.0	5.1	22.6	56.5	7.4
2.	53.0	10.0?	27.1	2.7	18.9?	51.1	5.1
3.	49.1	8.4	27.1	3.0	17.1	55.2	6.1
4.	43.0	9.3	23.0?	?	21.6	53.5?	?

1. Paralectotype, Kittl (1903: pl. 4, fig. 7).

2. Paralectotype, Kittl (1903: pl. 4, fig. 6).

3. Lectotype, Kittl (1903: pl. 4, fig. 4).

4. Paralectotype, Kittl (1903: pl. 4, fig. 5).

The suture is reproduced here in Figure 46J.

This species is known only from the Werfen Formation of Europe. The only other species of this genus, *D. kittli*, is known only from a single specimen from the *Columbites* fauna of southeastern Idaho. The two species are very similar.

Occurrence. Werfen Formation, Muć, Dalmatia.

Repository. Natural History Museum, Vienna.

Dalmatites kittli n. sp.

Plate 55, figures 7, 8; Text-figure 46

This species is established on a single specimen from the *Columbites* fauna of southeastern Idaho. The conch is smooth, compressed, involute, and is entirely phragmocone. It measures 33.5 mm for the width of the last whorl, and the umbilicus is 3.8 mm in diameter. The venter is acute, the lateral areas broadly convex. The broadest part of the whorl is in the mid-area of the whorl. The umbilical shoulder is rounded with a fairly steep umbilical wall. The conch is smooth except for growth lines. The pattern of the growth lines, however, is not visible due to faulty preservation of the shell.

The suture is illustrated on Figure 46K. It is of a fairly simple pattern with two lateral lobes, and an auxiliary lobe on the

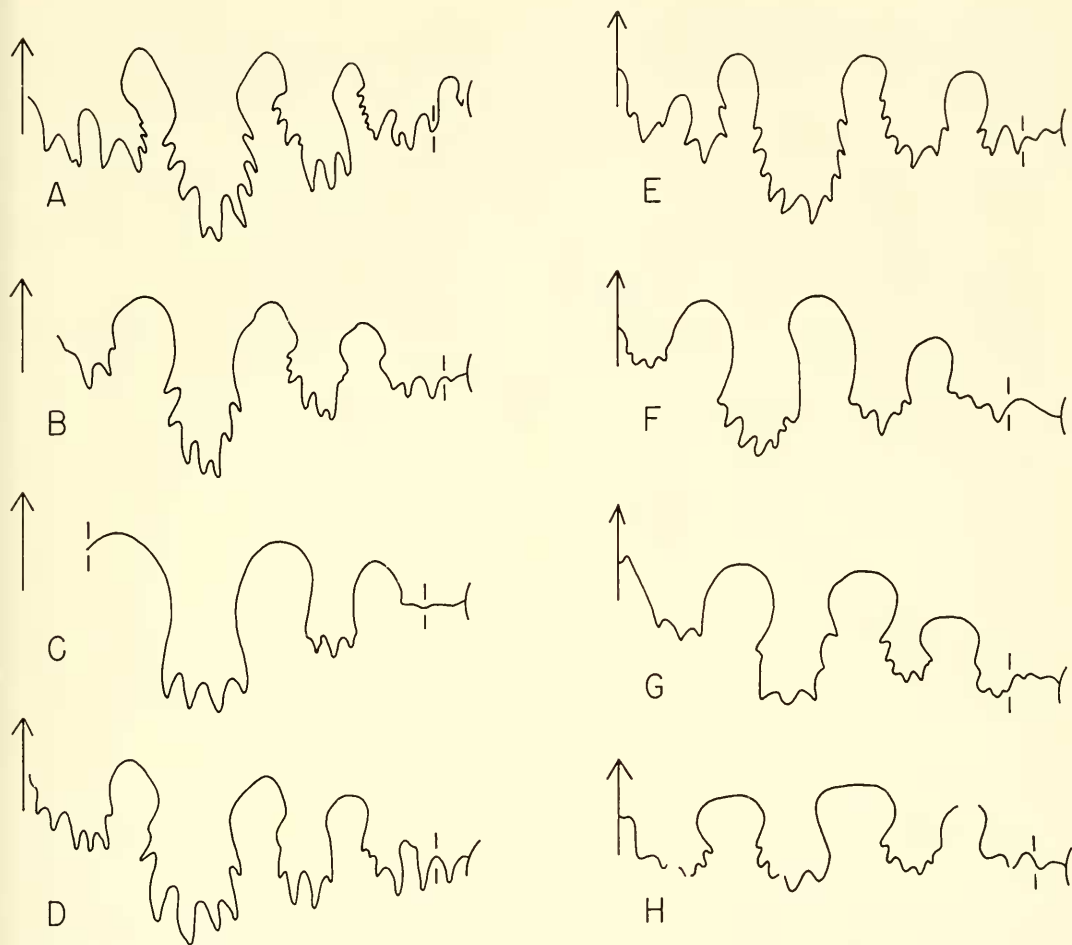


Figure 47. Diagrammatic representation of the sutures of three species of *Eophyllites*. A–F, *Eophyllites dieneri* (Arthaber); A, paralectotype (Arthaber, 1908: fig. 4), new drawing at a diameter of 42 mm; B, plesio-type (Arthaber, 1911: pl. 20(4), fig. 6), new drawing at a diameter of 47 mm; C, type specimen of *Manophyllites kingi*,—Arthaber (non Diener) = *Ussurites* (?) *decipiens* Spath (1934), at a diameter of approximately 30 mm; this suture is highly distorted due to excessive grinding of the specimen; D, holotype of *Manophyllites nopcsai* Arthaber (1908: pl. 12, fig. 5), new drawing at a diameter of 28 mm; E, holotype of *Manophyllites* (*Schizaphyllites*) *betillani* Renz and Renz (1948: pl. 4, fig. 8b), at a diameter of 47 mm; F, plesio-type (Renz and Renz, 1948: pl. 5, fig. 1b), at an unknown diameter. G, *Eophyllites orientalis* Spath,—Welter (1922: pl. 161(7), fig. 7), at an unknown diameter. H, *Eophyllites amurensis* Kiparisava (1961: text-fig. 104), at a whorl height of 10 mm.

Specimens of A–D from *Subcolumbites* fauna of Albania; E, F, from same fauna on Chios; G, from Nifaekoka, Black E, Timor; H, from *Subcolumbites* fauna, Primorye Region, Siberia.

dorsal areas of the flanks. It is difficult to be sure whether the lobes are really goniatitic as shown on Figure 46K. There are faint indications of denticulations on some of the first and second lateral lobes, and I suspect the smooth aspect is due to poor preservation.

Dalmatites morlaccus Kittl is morphologically very similar to *D. kittli*. The venter on the type species becomes rounded on the body chamber and the suture shows minor differences in proportion and shape of the elements.

Occurrence. Middle shale member of

Thaynes Formation (*Columbites* fauna), Paris Canyon, Bear River Range, South-east Idaho.

Repository. Holotype, MCZ 9499.

***Dalmatites attenuatus* Smith**

Plate 71, figures 8, 9;

Dalmatites attenuatus Smith, 1932: 81, pl. 57, figs. 11–13.

A highly compressed dalmatitid with a sharp venter. It is more compressed than either *D. morlaccus* or *D. kittli* and in addition more evolute. The suture is on the same basic pattern as the other species.

Occurrence. Smith's holotype came from the *Tirolites* Zone in Paris Canyon, south-east Idaho. He reports (Smith, 1932: 81) that he had only one specimen from the *Tirolites* Zone of Idaho but in addition he states the species was also found in the *Meekoceras* Zone at Phelan ranch, mouth of Cottonwood Canyon, east of the Ruby Range, Nevada; however, this latter specimen (or specimens?) is apparently no longer preserved. Smith (1932: 81) did describe a species—*D. richardsi*—from the *Meekoceras* Zone.

Repository. Holotype USNM 75023.

Order PHYLLOCERIDA Arkell, 1950

Superfamily PHYLLOCERATACEAE Zittel, 1884

Family USSURITIDAE Hyatt, 1900

Genus *Eophyllites* Spath, 1930

Type species, *Monophyllites dieneri* Arthaber, 1908

***Eophyllites dieneri* (Arthaber)**

Plate 22, figures 1–4; Plate 23, figures 1–7; Text-figure 47

Monophyllites dieneri Arthaber, 1908: 288, pl. 13(3), figs. 3a–c, 4a–c; Arthaber, 1911: 234, pl. 20(4), figs. 5–8; Diener, 1915: 203.

Eophyllites dieneri,—Spath, 1930: 89; Spath, 1934: 293–295; Kummel, in Arkell et al., 1957: L186.

Monophyllites hara,—Arthaber (non Diener), 1908: 286, pl. 12(2), figs. 4a–c; Arthaber, 1911: 235.

Monophyllites (Ussurites) hara Diener, 1915: 206.
Eophyllites refractus Spath, 1934: 295, pl. 3, fig. 4.
Monophyllites kingi,—Arthaber (non Diener), 1911: 235, pl. 20(4), figs. 12a–c.

Monophyllites (Ussurites) kingi Diener, 1915: 207.

Ussurites (?) *decipiens* Spath, 1934: 302 (= *Monophyllites kingi*,—Arthaber non Diener).

Monophyllites nopsai Arthaber, 1908: 287, pl. 12(2), figs. 5a–c; Arthaber, 1911: 235; Diener, 1915: 203.

Eophyllites nopsai,—Spath, 1934: 302.

Monophyllites (Leiophyllites) rosae Renz and Renz, 1947: 61, 77; Renz and Renz, 1948: 74, pl. 3, figs. 8–8a.

Monophyllites (Schizophyllites) betilloni Renz and Renz, 1947: 61, 78; Renz and Renz, 1948: 76, pl. 4, figs. 8–8b.

Monophyllites (Schizophyllites) betilloni var. *evoluta* Renz and Renz, 1948: 76, pl. 4, figs. 6–6a, pl. 5, figs. 2–2a, 4–4a, 6–6a.

The lectotype of this species is not in the collections of the Paleontological Institute, University of Vienna, and is presumed lost. Two figured paralectotypes are available, but none of the unfigured specimens noted by Arthaber. The one figured paralectotype (Arthaber, 1908: pl. 13(3), figs. 4a–c; 1911: pl. 20(4), figs. 5a–c; Pl. 23, figs. 2, 3 of this report) is mainly phragmocone. The lateral area of the illustrated side has been polished to expose the sutures, but at the same time this has destroyed all surface markings. The opposite side of the conch is all matrix or highly weathered. This specimen measures 49.5 mm in diameter, 20.6 mm for the height of the last whorl and 15.7 mm for the diameter of the umbilicus. The unretouched photograph of Plate 23, figures 2, 3 shows the main features of the conch and the general state of preservation of the specimen better than the retouched illustration of Arthaber.

The second paralectotype is the specimen which yielded the suture of Arthaber's plate 20(4), figure 6 and is illustrated here on Plate 23, figures 4, 5. It is a fragmentary specimen that is nearly all phragmocone. Much of the lateral area has been ground to expose the suture (Fig. 47B).

Monophyllites hara,—Arthaber, non Diener (1908: 286, pl. 12(2), fig. 4), renamed *Eophyllites refractus* by Spath (1934: 295) is unfortunately not preserved in the collections of the Paleontological Institute, University of Vienna. There are, however, several topotypes in the British Museum (Natural History). The species was characterized mainly by its broader venter. Spath (1934: 295) also mentions differences with *Eophyllites dieneri* in the pattern of the growth lines. In regard to the width of the venter, Spath himself stated that among the topotypes he had, they could not be distinguished satisfactorily from *E. dieneri*. As yet too few specimens of *Eophyllites* from Albania have been studied, but it does not seem likely that differences in the character of the venter as used in this case are anything more than the normal type of variation one can expect and can demonstrate in many cases within ammonite species. *Eophyllites refractus* is believed to be conspecific with *E. dieneri*.

Ussurites (?) *decipiens* Spath (1934) (= *Monophyllites kingi*,—Arthaber, 1911: pl. 20(4), fig. 12) is likewise believed to be a specimen of *E. dieneri*. Proper understanding of this species (and specimens) has not been possible on the basis of Arthaber's illustrations, especially of the suture. In the first place the type specimen (Plate 23, figures 6, 7) has the same general shape, etc., as the types of *E. dieneri*. The measurements are: diameter 50.8 mm, width of last whorl 12.0? mm, height of last whorl 18.8 mm, and width of umbilicus 18.3 mm. One of the most conspicuous differences is that *decipiens* is more evolute than *dieneri*; this difference, however, amounts to only 5 percent of the conch diameter and this is hardly a criterion of specific significance. The whorls are slightly more inflated than in *decipiens* and the venter is more broadly rounded than indicated by Arthaber's (1911: pl. 20(4), fig. 12b) drawing. The whorl cross-section is intermediate between

that of *E. decipiens* and *E. refractus*. The adoral quarter volution is marked by fine radial lines some of which at intervals are more conspicuous than others. The general absence of these lines on the two available specimens of *decipiens* is due to preservation plus grinding of the surface of the conch.

It is in the suture, however, that most authors recognized significant differences. As with practically all of the Albanian material, the suture can be made visible only by grinding and polishing of the surface. Arthaber's type specimen had been ground for this purpose and in this case the grinding was far too much, destroying many of the details of the lobe denticulations. Faint outlines of denticulations are visible on the lower flanks of the lobes. Arthaber's suture (1911: pl. 20(4), fig. 12c) actually ends on the umbilical shoulder and does not include anything for the umbilical wall. The suture on the umbilical wall is, however, not preserved. The relative shortness of the suture line reflects the difference in degree of involution and whorl height. The suture of *decipiens* illustrated by Arthaber came from a whorl height of 10.5 mm; the suture of *dieneri* (Arthaber, 1911: pl. 20(4), fig. 5) came from a whorl height of 17 mm. All of the above data clearly point to *Ussurites decipiens* as being part of the *dieneri* complex.

Eophyllites nopcsai (Arthaber), which is associated with *E. dieneri* in the Albanian fauna, is based on a single specimen; this is illustrated here on Plate 22, figures 1, 2. In suture (Fig. 47D) and ornamentation it is very much like *E. dieneri*, but its conch is very involute; its umbilicus is only 25 percent the diameter of the conch whereas in *dieneri* the umbilicus measures 30–36 percent the diameter of the conch. The association of this form in the same beds with *E. dieneri* and the very close similarity in all other conch features leads me to conclude that *nopcsai* represents nothing more than a variant toward involution of the conch, as *decipiens* represents a variant

in the opposite direction—that is, a more evolute conch.

The *Subcolumbites* fauna of Chios contains an interesting assemblage of specimens assigned to other species which I believe are conspecific with the Albanian *E. dieneri*. The specimens which Renz and Renz (1948: 74) named *Monophyllites* (*Leiophyllites*) *rosae* I cannot separate from *E. dieneri*. The specimens assigned by Renz and Renz (1948: 76) to *Monophyllites* (*Schizophyllites*) *betilloni* were set aside into a new subgenus on the basis of a slight saddle in the ventral lobe. The suture of the subgenotype (Fig. 47E) is nearly identical to that of the suture of the paralectotype of *E. dieneri* (Fig. 47A). Spath (1934: 294) had earlier called attention to the variability in the suture of *E. dieneri* and especially to the ventral lobe. He also rightly cautioned that some of this variability is caused by preparation of the suture with acids and grinding. In all other features *betilloni* resembles *E. dieneri*, and there appears little doubt but that these two species are conspecific.

The form from Timor described by Welter (1922: 118, pl. 161(7), figs. 5–7) as *Monophyllites* nov. sp. ex aff. *dieneri* was renamed *Eophyllites orientalis* by Spath (1934: 295). This species is based on a single incomplete specimen that represents the inner whorls of what was a much larger form. It is unquestionably very close to *E. dieneri* and possibly even conspecific, but here again, since it is based on a single specimen, it is considered best for the moment to recognize it as a distinct species.

Occurrence. *Subcolumbites* fauna of Këçira, Albania, and Chios.

Repository. The Paleontological Institute, University of Vienna, contains two paralectotypes of *E. dieneri*; the lectotype is apparently lost. This collection also contains the holotype of *Ussurites* (?) *decipiens* Spath (= *Monophyllites kingi*,—Arthaber non Diener). A number of topotypes are in the British Museum (Natural History), C22939–47, C22979. The Natural History

Museum, Basel, contains the following specimens from the *Subcolumbites* fauna of Chios: holotype *Monophyllites* (*Leiophyllites*) *rosae* Renz and Renz (1948: pl. 3, fig. 8) NHMB J13746; holotype *Monophyllites* (*Schizophyllites*) *betilloni* Renz and Renz (1948: pl. 4, fig. 8) NHMB J13756; var. *evoluta* Renz and Renz (1948: pl. 4, fig. 6) NHMB J13757, (pl. 5, fig. 2) NHMB J13758, (pl. 5, fig. 4) NHMB J13759, (pl. 5, fig. 6) NHMB J13760; unfigured paratypes from Maradavuno, NHMB J13761, from Kephlovuno NHMB J13762.

Eophyllites orientalis Spath

Text-figure 47

Monophyllites nov. spec. ex aff. *dieneri*,—Welter, 1922: 118, pl. 161(7), figs. 5–7; Kutassy, 1933: 595.

Eophyllites orientalis Spath, 1934: 295.

This Timor species is based on a single specimen that represents the inner whorls of what was a much larger form. The specimen measures 56.7 mm in diameter, 16.0 mm for the width of the last whorl, 23.0 mm for the height of the last whorl, and 19.1 mm for the diameter of the umbilicus. It shows a great similarity to *E. dieneri* of Albania and Chios and perhaps is conspecific with that form. However, because only one specimen is known and because there are minor differences in the suture (Fig. 47G) and conch features, it is considered best to maintain the separate identity of this species until more material becomes available.

Occurrence. Manganese coated blocks from Nifoekoko, Timor.

Repository. GPIBo-W215.

Eophyllites amurensis Kiparisova

Text-figure 47

Eophyllites amurensis Kiparisova, 1961: 137, pl. 28, figs. 7, 8, text-fig. 104.

Eophyllites cf. *refractus*,—Kiparisova, 1961: 136, pl. 28, fig. 9, text-fig. 103.

The two forms of *Eophyllites* recognized by Kiparisova from the Primorye Region

represent an inflated form (cf. *refractus*) and a more compressed form (*amurensis*). The latter species was compared closely with *dieneri* from the *Subcolumbites* fauna of Albania. One of these species (cf. *refractus*) is based on a single specimen and the other (*amurensis*) was based on three poorly preserved specimens. They are in the first place considered to represent a single species complex. These specimens differ from *E. dieneri* in being slightly more involute and in the slightly simpler structure. They are clearly closely related to the *dieneri* group of Albania and could well be conspecific but much more material is needed before this relationship can be established with any degree of certainty.

Occurrence. The three specimens of *amurensis* came from the *Subcolumbites* fauna on the west coast of Amur Bay between Cape Atlasov and Cape Ugolny, Ussuri Bay, Primorye Region. The single specimen assigned by Kiparisova to cf. *refractus* came from the east coast of Ussuri Bay between Cape Kom-Pikho-Sakho and Cape Chigan from an uncertain horizon.

Genus *Palaeophyllites* Welter, 1922

Type species, *Palaeophyllites steinmanni* Welter, 1922

Palaeophyllites steinmanni Welter

Palaeophyllites steinmanni Welter, 1922: 119, pl. 162(8), figs. 5, 6, 7, pl. 163(9), figs. 3–6; Kutassy, 1933: 606; Spath, 1934: 297, fig. 103. *Monophyllites (Palaeophyllites) thalmani* Renz and Renz, 1947: 61, 78; Renz and Renz, 1948: 79, pl. 3, figs. 10–10b (= *Palaeophyllites steinmanni* Welter, 1922: pl. 163(9), figs. 3–6 (non pl. 162(8), figs. 5–7)).

Monophyllites (Palaeophyllites) praekiepertii Renz and Renz, 1947: 61, 78; Renz and Renz, 1948: 80, pl. 4, figs. 5–5b.

Renz and Renz (1948) established the species *thalmani* for the specimen illustrated by Welter on his plate 163(9), figures 3–6, at the same time designating the specimen of Welter's plate 162(8), figures 5, 6, as "holotype." They were un-

TABLE 50. MEASUREMENTS OF SPECIMENS OF *PALAEOPHYLLITES STEINMANNI* FROM TIMOR AND CHIOS.

	D	W	H	U	W/D	H/D	U/D
1.	58.8	14.9	20.4	24.5	25.3	34.7	41.7
2.	48.2	12.1	16.4	20.5	25.1	34.0	42.5
3.	40.7	12.0	13.8	16.6	29.5	33.9	40.8
4.	31.5	12.2	10.7	14.3	38.7	34.0	45.4
5.	26.0	8.7	8.7	10.8	33.5	33.5	41.5
6.	23.4	7.9	10.1	7.9	33.8	43.2	33.8

1. Lectotype, Welter (1922: pl.162(8), figs. 5–7), GPIBo W216a.
2. Plesiotype, *Palaeophyllites thalmani* Renz and Renz (1948: pl. 3, fig. 10), NHMB J13764.
3. Paralectotype, Welter (1922: pl.163(9), figs. 3–4), GPIBo W216b.
4. Holotype, *Monophyllites (Palaeophyllites) praekiepertii* Renz and Renz (1948: pl. 4, fig. 5), NHMB J13766.
5. Paralectotype, Welter (1922: pl.163(9), figs. 5–6), GPIBo W216c.
6. Unfigured specimen from Chios, *Monophyllites (Palaeophyllites) thalmani*, NHMB J13765.

aware that Spath (1934: 298) had previously designated this specimen as lectotype. The smaller specimens of Welter's plate 163(9), figures 3–6, are characterized by a more subdued ribbing pattern. These specimens are clearly juvenile forms; the ornamentation increases on the mature body chamber. The Chios and Timor specimens of "*thalmani*" are immature forms but clearly conspecific. The species *praekiepertii* established by Renz and Renz (1948: 80) is merely a small, juvenile specimen of *steinmanni*. Measurements for 6 specimens from Timor and Chios are given on Table 50.

Occurrence. *Subcolumbites* fauna of Chios and the *Prolungarites* fauna with manganese coated fossils of Timor.

Repository. Lectotype, GPIBo-W216a; paralectotypes GPIBo-W216b, c; specimens from Chios, plesiotype *Monophyllites (Palaeophyllites) thalmani* Renz and Renz (1948: pl. 3, fig. 10) NHMB J13764; unfigured specimen from Maradovuno NHMB J13765, from Kephalovuno NHMB J13836; holotype *Monophyllites (Palaeophyllites) praekiepertii* Renz and Renz (1948, pl. 4, fig. 5) NHMB J13766; unfigured paratype NHMB J13767.

TABLE 51. MEASUREMENTS OF *USSURITES SIEVERI* N. SP. FROM TOBIN FORMATION, NEVADA.

	D	W	H	U	W/D	H/D	U/D
1.	62.5	20.0	25.8	17.3	32.0	41.2	27.6
2.	48.0	16.4	21.8	13.2	34.1	45.4	27.5
3.	48.0	15.3	21.4	13.7	31.8	44.5	28.5
4.	43.0	14.5?	19.5?	10.0	34.4?	45.3?	23.0
5.	38.7	?	16.5	11.5	?	42.6	29.7
6.	38.4	?	15.5	10.0	?	40.3	26.0
7.	33.5	11.4	14.4	9.3	34.0	42.9	27.7
8.	26.7	10.4	12.3	6.8	38.9	46.0	25.4
9.	25.0	?	11.1	6.4	?	44.4	25.6
10.	21.0	7.8	9.1	6.1	37.2	43.3	29.0
11.	20.6	8.4	9.0	5.7	40.7	43.6	27.6
12.	20.0	7.7	9.0	4.8	38.5	45.0	24.0

1. Holotype, MCZ 9452 (Pl. 32, figs. 1, 2).
3. Paratype, MCZ 9456 (Pl. 32, figs. 6, 7).
4. Paratype, MCZ 9455 (Pl. 32, fig. 5).
5. Paratype, MCZ 9454 (Pl. 32, fig. 4).
6. Paratype, MCZ 9472 (Pl. 35, figs. 10, 11).
10. Paratype, MCZ 9464 (Fig. 48 CD).
2, 6, 7, 9, 11, 12. Unfigured paratypes, MCZ 9484.

Genus *Ussurites* Hyatt, 1900
Type species, *Monophyllites sichoticus*
Diener, 1895

Ussurites sieveri n. sp.
Plate 31, figure 8; Plate 32, figures 1–7; Plate 35, figures 10, 11; Text-figure 48

This species is well represented in the Tobin Formation fauna. There are twelve specimens sufficiently well preserved and complete to allow measurements, which are given on Table 51.

The conch is moderately involute with a rounded venter, broadly rounded lateral areas, a well rounded umbilical shoulder, and a vertical umbilical wall. The flanks bear low, narrow, slightly prosiradiate folds that cross the venter.

The sutures from a whorl height of 2.0 mm to a whorl height of 14.8 mm are shown in Figures 48A–D. The suture is typical for the genus, with the asymmetric, club-shaped saddles, the large denticulated first lateral lobe, etc.

This species differs from *Ussurites mansfieldi* n. sp. in conch form and suture. The latter species is quite distinctive in its large asymmetrical second lateral saddle; like-

wise the ontogenetic changes in the whorl shape are quite different. *Ussurites hosei* n. sp. is a much more robust species, with a more inflated whorl section and a suture with coarser denticulations on the lobes.

Occurrence. Tobin Formation, Pershing County, Nevada; south tip of Tobin Range, Cain Mountain 1:62,500 quad., center NW ¼ sec. 9, T. 26N, R. 39E, 5,500 ft. S, 27.5 ft. W from elevation point 5088 on range crest.

Repository. Holotype MCZ 9452 (Pl. 32, figs. 1, 2); paratypes MCZ 9464 (Pl. 31, fig. 8), MCZ 9453 (Pl. 32, fig. 3), MCZ 9454 (Pl. 32, fig. 4), MCZ 9455 (Pl. 32, fig. 5), MCZ 9456 (Pl. 32, fig. 6, 7), MCZ 9472 (Pl. 35, figs. 10, 11); unfigured paratypes MCZ 9484; suture specimen (Figures 48C, D), MCZ 9464.

Ussurites hosei n. sp.
Plate 33, figures 1–6; Text-figure 48
This new species is based on a fairly large assortment of fragmentary and partially crushed specimens that are, however, so distinctive that a description and new name is warranted. The conch is robust, and moderately involute. None of the specimens are in a state of preservation or completeness to yield any significant measurements. The whorl section is broadly oval and quite variable in relative width-height dimensions. Most of the material shows the whorl width to be approximately 75 per cent of the whorl height, thus slightly compressed. On the other hand, fragments of whorls are present in which the whorl height and width are approximately the same, and in some specimens the whorls are depressed, that is, the whorl width is greater than the whorl height.

The venter is broadly rounded grading onto broadly arched flanks. The umbilical shoulder is rounded, and merges with a broad, nearly vertical umbilical wall. The umbilicus appears to measure approximately 20–25 per cent the diameter of the conch.

None of the specimens are really sufficiently well preserved to show surface

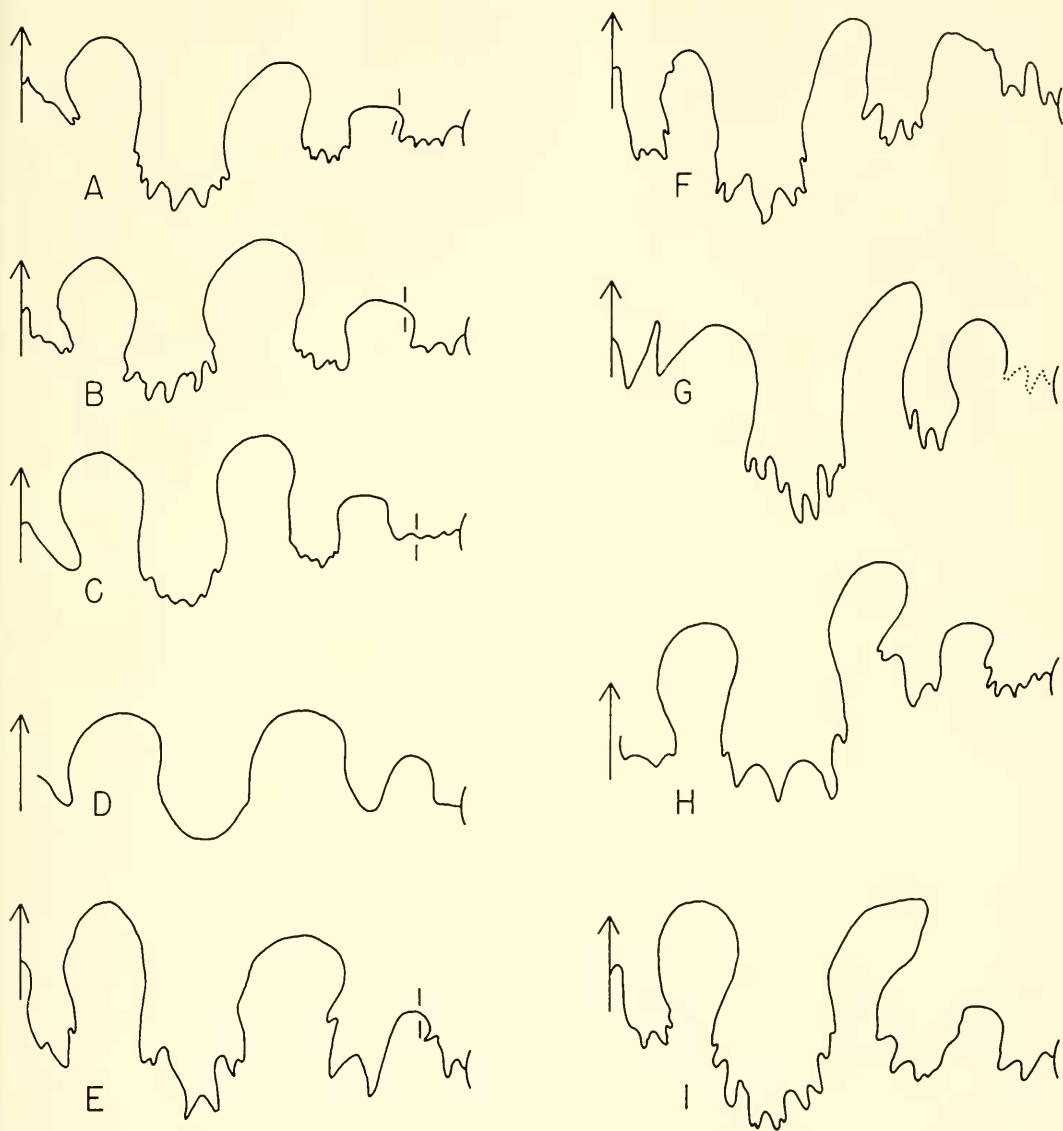


Figure 48. Diagrammatic representations of the suture of: A–D, *Ussurites sieveri* n. sp. A, holotype at a diameter of 35 mm (MCZ 9452); B, paratype at a diameter of 26 mm (MCZ 9472); C, paratype at a diameter of 21 mm; D, at a diameter of 13 mm (MCZ 9464); E, paratype of *Ussurites hoesi* n. sp. at a diameter of 53 mm (USNM 153089); F–I, *Ussurites mansfieldi* n. sp.; F, paratype (Pl. 45, figs. 2, 3), at a diameter of 110 mm; G, at a diameter of 75 mm (MCZ 9515, Pl. 44, fig. 1); H, at a diameter of 43 mm (MCZ 9513, Pl. 44, figs. 2, 3); I, at a diameter of 24 mm (USNM 153090).

Specimens of figures A–D are from Tabin Formation, Nevada, that of figure E from Thaynes Formation, Confusion Range, Nevada, and those of figures F–I, from *Columbites* fauna, Thaynes Formation, southeastern Idaho.

TABLE 52. MEASUREMENTS OF *USSURITES MANSFIELDI* N. SP. FROM THE COLUMBITES ZONE, SOUTHEASTERN IDAHO.

	D	W	H	U	W/D	H/D	U/D
1.	203.0	?	93.0	53.0	?	45.8	26.1
2.	126.0	39.5?	53.6	38.0	31.3?	42.5	30.2
3.	48.0	?	24.2	12.8	?	50.4	26.7
4.	43.0	?	20.6	13.6	?	47.9	31.6
5.	37.7	18.0	18.7	11.4	47.7	49.6	30.2

1. Holotype, State Historical Museum, Boise.

2. Paratype, State Historical Museum, Boise.

3. Paratype, MCZ 9513 (Pl. 44, figs. 2, 3).

4, 5. Paratypes, USGS.

marking of any kind. One of the larger phragmocones (Pl. 33, fig. 1) does appear to have broad, low, radial folds on the flanks. The suture is typical for the genus, and is illustrated on Figure 48E. It is somewhat like the suture of *U. sieveri* but has much coarser denticulation of the lobes; it differs from the suture of *U. mansfieldi* to a very marked degree.

Occurrence. Collection M111, 1,420 to 1,530 feet above the base, Thaynes Formation, Confusion Range, Utah, from section 15 of Hose and Repenning (1959).

Repository. Holotype, USNM 153085 (Pl. 33, fig. 1); paratypes USNM 153086 (Pl. 33, fig. 2), USNM 153087 (Pl. 33, figs. 3, 4), USNM 153088 (Pl. 33, figs. 5, 6); suture specimen USNM 153089 (Fig. 48E).

Ussurites mansfieldi n. sp.

Plate 44, figures 1–3; Plate 45, figures 1–3; Text-figure 48

The *Columbites* fauna of southeastern Idaho has yielded 10 specimens of this most interesting species. The available measurements of five of these specimens are listed in Table 52. There is one exceptionally large specimen, one of intermediate size, and the remaining forms of relatively small diameter. The largest specimen, and holotype, is preserved only on one side and the adoral one-half volution, which is body chamber, is crushed. The inner volutions are not crushed. These

inner volutions have rounded lateral areas, rounded umbilical shoulders and a steep, rounded umbilical wall. The height of the whorl in relation to the width increases greatly during shell growth. On approximately the first two volutions, the whorl width and height are much the same; on later volutions the whorls increase rapidly in height whereas the width increases quite modestly. At all stages of growth the venter is broadly rounded.

The shell of the body chamber of the large holotype bears fine, slightly sinuous growth lines which are periodically bundled to give rise to faint broad ribs. On the inner volutions the shell bears faint strigations in addition to extremely fine growth lines.

The large paratype (Pl. 45, figs. 2, 3) is all phragmocone with much of the shell preserved. The widely spaced, low, broad radial ribs are more conspicuous on this specimen, as are the fine, sinuous growth lines.

The small specimens show the whorl width to approximate the whorl height. Likewise, the shell is smooth, except for extremely fine growth lines and strigations.

Probably the most distinguishing feature of this species is the suture (Figure 48F–I). There is a large denticulated first lateral lobe, a much smaller second lateral lobe and an auxiliary series on the umbilical shoulder and wall. The saddles, however, are unusual, especially the long asymmetrical second lateral saddle. Figure 48 compares four sutures taken from a whorl height of 12 mm (diameter of approximately 24 mm) to one taken from the paratype at a whorl height of 47 mm (diameter of approximately 110 mm). The distinctive character of the suture is already well established at a small diameter. It is interesting to note that on the late mature suture (Fig. 48F) a “degeneration” occurs, expressed in the wavy outline of the saddles and to some extent in the lobes.

The large, asymmetrical second lateral saddle sets this species apart from all other

species of *Ussurites*. In addition to the suture, the general shape and configuration of the conch is distinctive. The two other American species of *Ussurites*, *U. sieveri* and *U. hosei*, are quite different; however, here the age factor may be significant. *Ussurites mansfieldi* is from the *Columbites* Zone. Nearly all other Scythian species of *Ussurites* are from the next higher *Subcolumbites* Zone.

Occurrence. The holotype and paratype were collected by Mr. Gordon R. Stephenson in Webster Canyon, Freedom Quadrangle, southeast Idaho (Sec. 1, T. 8S, R. 45E and Sec. 6, T. 8S, R. 46E). The paratype was found in a black limestone concretion within a 42 foot dark shale and thin limestone bed 120 feet above the *Meekoceras* limestone. The holotype was not found in place, but in a concretion at the base of a cliff with the above mentioned concretions which yielded the paratype. In addition, the species is known from the *Columbites* fauna at Hot Springs, southeast Idaho, and along Draney Creek, Stewart Flat Quadrangle, southeast Idaho (USGS Locality M98).

Repository. Holotype and large paratype (Pl. 45, figs. 1–3) are in the Department of Geology, Washington State University, Pullman, Washington; figured paratypes MCZ 9513 (Pl. 44, figs. 2, 3) and MCZ 9515 (Pl. 44, fig. 1); unfigured paratypes from Hot Springs MCZ 9514; suture specimen (Fig. 48I) USNM 153090.

Genus *Leiophyllites* Diener, 1915

Type species, *Monophyllites suessi* Mojsisovics, 1882

Leiophyllites variabilis (Spath)

Plate 22, figures 5–10; Text-figures 49, 50

Monophyllites pitamaha,—Arthaber (non Diener) 1911: 234, pl. 20(4), figs. 9–11; C. Renz, 1928: 155.

Monophyllites (*Leiophyllites*) *pitamaha* Diener, 1915: 205.

Monophyllites (*Leiophyllites*) aff. *pitamaha*,—Renz and Renz, 1947: 61; Renz and Renz, 1948: 76, pl. 3, figs. 9–9a, pl. 4, figs. 7–7b.

Eophyllites variabilis Spath, 1934: 296, pl. 2, fig. 3, pl. 6, fig. 1, pl. 7, fig. 1.

Eophyllites variabilis var. *involuta* Spath, 1934: 296 (= Arthaber, 1911: pl. 20(4), fig. 9).

Eophyllites variabilis var. *evoluta* Spath, 1934: 296, pl. 4, fig. 1.

Monophyllites (*Leiophyllites*) *praeconfucii* Renz and Renz, 1947: 61, 77; Renz and Renz, 1948: 73, pl. 4, figs. 1–1b, 2–2a.

Monophyllites (*Leiophyllites*) *georgalasi* Renz and Renz, 1947: 61, 77; Renz and Renz, 1948: 74, pl. 4, figs. 3–3a.

Monophyllites (*Leiophyllites*) *palacotriadicus* Renz and Renz, 1947: 61, 78; Renz and Renz, 1948: 75, pl. 4, figs. 4–4a.

Leiophyllites praematurus Kiparisova, 1958b: pl. 7, fig. 13, text-fig. 17b; Kiparisova, 1961: 134, pl. 28, figs. 5, 6, text-figs. 101, 102.

The lectotype of this species (Arthaber, 1911: pl. 20(4), fig. 11) is not preserved in the collection of the Paleontological Institute, Vienna; the two figured paralectotypes (Arthaber, 1911: pl. 20(4), figs. 9, 10; Pl. 22, figs. 5–10 of this report) are fortunately still preserved and available for study. These two paralectotypes plus one additional unfigured specimen (Pl. 22, figs. 7, 8) and the many topotypes in the British Museum (Natural History) are not well preserved and the larger of the paralectotypes (Pl. 22, figs. 5, 6) has been ground and polished.

The Chios fauna contains a fair number of specimens which belong to this species but which Renz and Renz (1948) placed in four distinct species. The differences between these species are mainly in whorl dimensions and expressions of fine ornamentation. The measurements of the Chios and Albania specimens considered to belong to this species are listed on Table 53 and plotted on the graph of Figure 50. These data do not suggest that the differences in whorl dimensions are anything more than what should be expected. It is, however, possible that some of the unfigured specimens in the Chios collection placed here (e.g. the more involute forms) are really species of *Eophyllites*. In regard

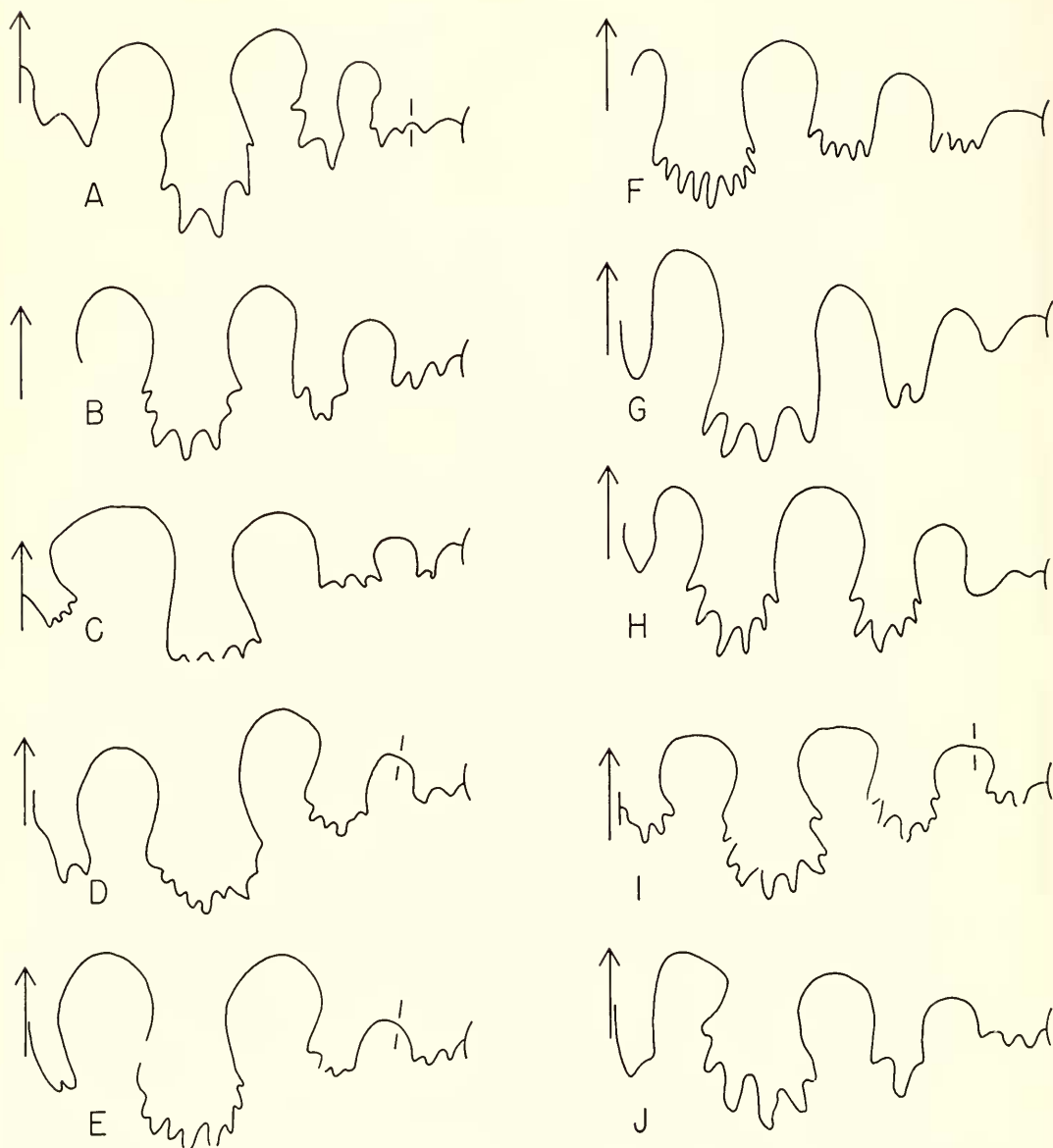


Figure 49. Diagrammatic representation of the suture of: A, paralectotype *Eophyllites variabilis* Spath (= *Monophyllites pitamaha* Arthaber [non Diener] 1911: pl. 20(4), fig. 10c; Pl. 22, figs. 5, 6 of this report), from *Subcolumbites* fauna of Albania at a diameter of 28 mm; B, paratype *Leiophyllites praematurus* Kiparisova (1961: 135, fig. 101), from *Subcolumbites* fauna, Primorye Region, Siberia; C, holotype *Leiophyllites radians* Astakhova (1960a: 146, fig. 12), from *Stacheites* Zone of Astakhova (1960a) Mangyshlak Peninsula; D, holotype *Danubites* (*Prellarianites*) *maritimus* Kiparisova (1961: 146, fig. 111), from *Subcolumbites* fauna of Primorye Region, Siberia, at a whorl height of 8 mm; E, holotype *Danubites* (*Prellarianites*) *inflatus* Kiparisova (1961: 145, fig. 110), from the *Subcolumbites* fauna of Primorye Region, Siberia, at a whorl height of 7 mm; F, holotype *Leiophyllites serpentinus* Chao (1959: 149, fig. 48a), from *Subcolumbites* fauna of Kwangsi, China, at a whorl height of 16 mm; G, holotype *Leiophyllites serpentinus* Chao (1959: 149, fig. 48c), from *Subcolumbites* fauna of Kwangsi, China, at a diameter of 23 mm; H, holotype *Leiophyllites oxynatus* Chao (1959: 150, fig. 48b), from *Subcolumbites* fauna of Kwangsi, China, at a whorl height of 10 mm; I, holotype *Danubites* (*Danubites*) *incertus* Kiparisova (1961: 143, fig. 108), from *Subcolumbites* fauna of the Primorye Region, Siberia, at a whorl height of 10 mm; J, holotype *Danubites* (*Danubites*) *admaris* Kiparisova (1961: 142, fig. 106), from *Subcolumbites* fauna of the Primorye Region, Siberia, at a whorl height of 7 mm.

to surface ornamentation, the differences noted by various authors are more a reflection of preservation than anything else. The sutures, likewise, in all these species have the same basic pattern with minor differences which I consider to be intra-specific. The suture of the paralectotype as reproduced by Arthaber (1911: pl. 20(4), fig. 10c) is idealized. The suture was exposed by grinding and a new drawing is reproduced here on Figure 49A.

Comparison with the other upper Scythian species of *Leiophyllites*, namely from the *Subcolumbites* fauna of Kwangsi, China, and *L. praematurus* from the *Subcolumbites* fauna of the Primorye Region, is difficult because of lack of information on these species. Chao (1959) described four species of *Leiophyllites* on the basis of seven specimens. These species were separated by minor morphological features that appear more understandable as reflections of the rather poor preservation. On the features of conch evolution and whorl shape and dimensions, this species cannot be separated from *L. variabilis* from Albania and Chios. However, the sutures of these Kwangsi specimens are simpler than the Albanian and Chios species (Fig. 49), and on this basis I believe they should be kept in a distinct species group.

A species which I believe to be conspecific with *L. variabilis* is *L. praematurus* Kiparisova (1958b). That author compared her species mainly with Middle Triassic species of *Leiophyllites*, merely noting the similarity of the conch to that of *L. variabilis*. In this regard she pointed to the lesser denticulation of the lobes as an important distinction. The suture pattern of *L. praematurus* as illustrated by Kiparisova falls well within the variations found within the Chios specimens of *L. variabilis* (Fig. 49).

Occurrence. *Subcolumbites* fauna of Albania, Chios, and Primorye Region.

Repository. The primary types are in the Paleontological Institute, University of Vienna; the lectotype (Arthaber, 1911: pl. 20(4), fig. 11) is apparently lost, but two

TABLE 53. MEASUREMENTS OF *LEIOPHYLLITES VARIABILIS* (SPATH) FROM THE *SUBCOLUMBITES* FAUNAS OF ALBANIA AND CHIOS.

	D	W	H	U	W/D	H/D	U/D
1.	96.2	20.6	33.8	37.2	21.4	35.1	38.7
2.	68.8	16.7	20.0	34.3	24.3	29.1	49.9
3.	60.7	17.4	20.2	26.4	28.7	33.3	43.5
4.	52.2	13.5	15.0	27.0	25.9	28.7	51.7
5.	41.0	9.8	11.2	27.8	23.9	27.3	67.8
6.	39.5	10.5?	12.0	19.2	26.6?	30.4	48.6
7.	38.4	12.3	11.3	19.0	32.0	29.4	49.5
8.	37.4	12.5?	12.0	17.6	33.4?	32.1	47.1
9.	35.2	9.1	13.1	13.8	25.9	37.2	39.2
10.	34.5	8.2	12.0	14.5	23.8	34.8	42.0
11.	33.7	6.7	10.0	15.5	19.9	29.7	46.0
12.	30.5	8.0	9.3	13.3	26.2	30.5	43.6
13.	28.0	7.4	10.4	11.0	26.4	37.1	39.3
14.	26.5	7.7	9.1	10.6	29.1	34.3	40.0
15.	24.6	6.0	9.3	9.5	24.4	37.8	38.6
16.	21.5	6.3?	6.8	9.8	29.3?	31.6	45.6
17.	21.0	6.3	7.5	7.3	30.0	35.7	34.8
18.	19.1	5.8	7.4	7.0	30.4	38.7	36.6
19.	19.0	4.4	5.8	8.5	23.2	30.5	44.7
20.	18.0	5.3	7.0	5.6	29.4	38.9	31.1
21.	17.3	5.2	6.6	5.8	30.1	38.2	33.5

1. Plesiotype, *Monophyllites* (*Leiophyllites*) aff. *pitamaha*,—Renz and Renz (1948: pl. 3, figs. 9–9a), NHMB J13752.
2. Holotype, *Monophyllites* (*Leiophyllites*) *praeconfucii* Renz and Renz (1948: pl. 4, figs. 1–1b), NHMB J13740.
3. Plesiotype, *Monophyllites* (*Leiophyllites*) aff. *pitamaha*,—Renz and Renz (1948: pl. 4, figs. 7–7b), NHMB J13753.
4. 5. Unfigured paratypes, *Monophyllites* (*Leiophyllites*) *praeconfucii* Renz and Renz from Maradovuno, NHMB J13742.
6. Paratype, *Monophyllites* (*Leiophyllites*) *praeconfucii* Renz and Renz (1948: pl. 4, fig. 2–2a), NHMB J13741.
7. Holotype, *Monophyllites* (*Leiophyllites*) *gcorgalasi* Renz and Renz (1948: pl. 4, figs. 3–3a), NHMB J13744.
8. Holotype, *Monophyllites* (*Leiophyllites*) *palacotriadicus* Renz and Renz (1948: pl. 4, figs. 4–4a), NHMB J13749.
- 9–11, 13–15, 17–21. Unfigured specimens of *Monophyllites* (*Leiophyllites*) aff. *pitamaha* from Maradovuno, NHMB J13754.
12. Paralectotype, *Eophyllites variabilis* Spath (= *Monophyllites pitamaha* Arthaber (non Diener), 1911: pl. 20(4), figs. 10 a–c), PIUV.
16. Paralectotype, *Eophyllites variabilis* Spath (= *Monophyllites pitamaha* Arthaber (non Diener), 1911: p. 20(4), figs. 9a, b), PIUV.

figured paralectotypes (Arthaber, 1911: pl. 20(4), figs. 9, 10) and one unfigured paralectotype of Arthaber are preserved in that institution. A large collection of topotypes is in the British Museum of Natural His-

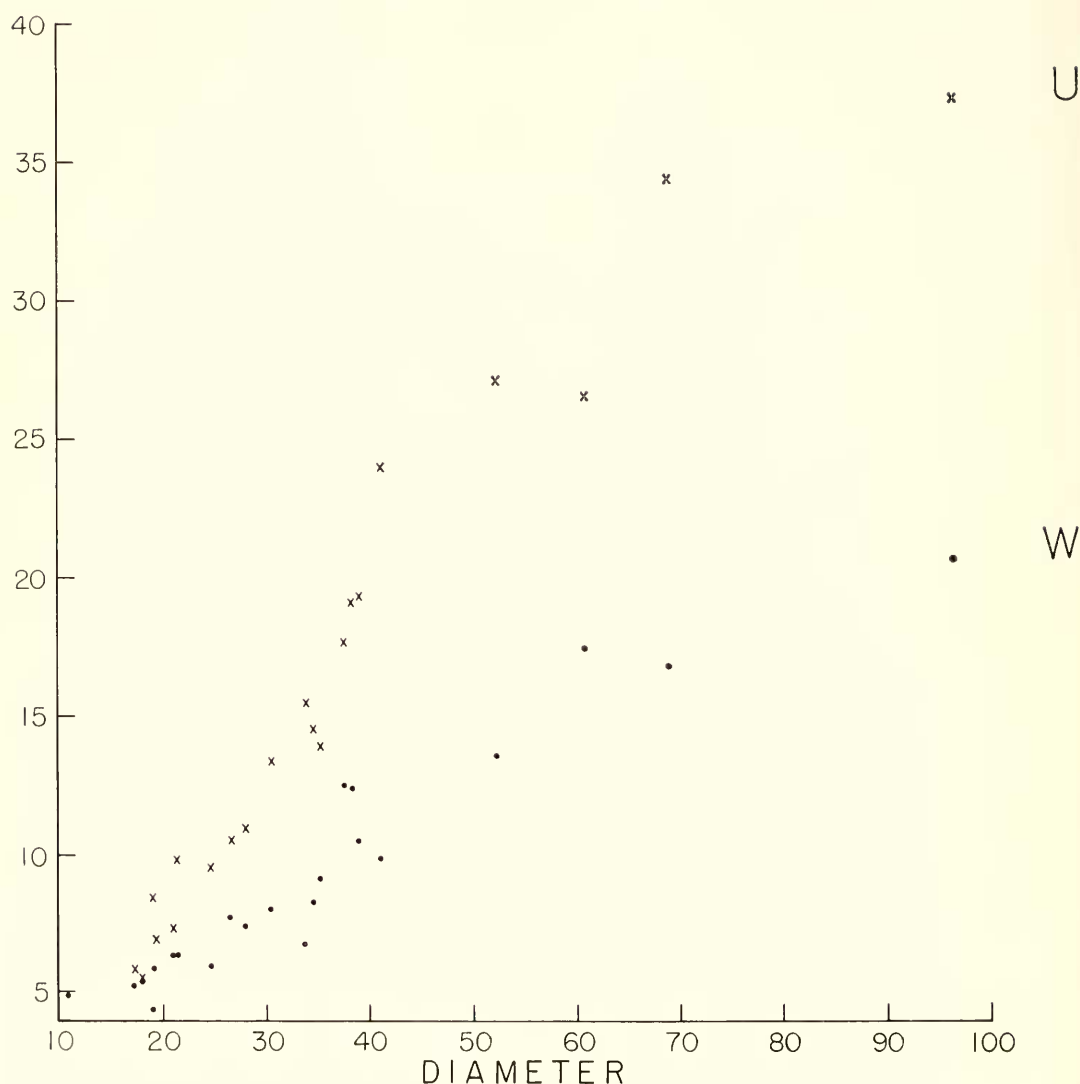


Figure 50. Variation in umbilical diameter (U) and whorl width (W) of *Leiophyllites variabilis* from Subcolumbites faunas of Albania and Chios. The data on this graph are from Table 53.

tory. The Natural History Museum, Basel, contains the following specimens from Chios studied by Renz and Renz (1948): plesiotype, *Monophyllites* (*Leiophyllites*) aff. *pitavalis* Renz and Renz (1948: pl. 3, fig. 9) NHMB J13752, (pl. 4, fig. 7) NHMB J13753; unfigured specimens from Maradovuno NHMB J13754, from Keph-
halovuno NHMB J13755; holotype, *Mono-*

phyllites (*Leiophyllites*) *praeconfucii* Renz and Renz (1948: pl. 4, fig. 1) NHMB J13740; paratype (pl. 4, fig. 2) NHMB J13741; unfigured paratypes from Maradovuno NHMB J13742, from Keph-
halovuno NHMB J13743; holotype, *Monophyllites* (*Leiophyllites*) *georgalasi* Renz and Renz (1948: pl. 4, fig. 3) NHMB J13744; unfigured paratypes NHMB J13745; holotype,

Monophyllites (*Leiophyllites*) *palaeotriadicus* Renz and Renz (1948: pl. 4, fig. 4) NHMB J13749; unfigured paratypes from Maradvuno NHMB J13750, from Kephlovuno NHMB J13751.

Leiophyllites radians Astakhova

Text-figure 49

Leiophyllites radians Astakhova, 1960a: 146, pl. 3-4, fig. 10, text-fig. 12.

This species has the general leiophyllitid conch form but is characterized by broadly spaced, low radial ribs that cross the venter. Adorally the ribs tend to decrease in size and eventually disappear. The suture is shown on Figure 49C. Assuming that it is accurately drawn, it is a much simpler suture than that of most other species of this genus. The only other species of *Leiophyllites* that have ornamentation consisting of ribs are the two species from the Primorye Region (*L. maritimus* and *L. admaris*). However, these two species have quite different ribbing patterns and very different sutures (Fig. 49).

Occurrence. *Stacheites* Zone of Astakhova (1960a) Mangyshlak Peninsula.

Leiophyllites serpentinus Chao

Text-figure 49

Leiophyllites serpentinus Chao, 1959: 149, 331, pl. 42, figs. 7, 13-15, text-fig. 48a.

Leiophyllites oxynotus Chao, 1959: 150, 332, pl. 42, figs. 11, 12, text-fig. 48b.

Leiophyllites lolouensis Chao, 1959: 150, 332, pl. 42, figs. 8-10, text-fig. 48c.

Leiophyllites aff. *pitamaha* Chao, 1959: 150, 332, pl. 42, fig. 1.

Leiophyllites kwangsiensis Chao, 1959: 7, 160, (*nomen nudum*).

Leiophyllites vermiformis Chao, 1959: 7, 160 (*nomen nudum*).

All the species listed above in the synonymy are based on one or very few specimens of only fair preservation, and all came from the same horizon and locality. Chao describes the venter on some of his species as fastigate but this is not apparent on the illustration of the species. On the basis of the data available, all these species have the general conch architecture of *L. vari-*

abilis and are considered to be conspecific. They differ from *L. variabilis* in the suture (Fig. 49).

Occurrence. Limestone block (Chao collection 542b) Kwangsi, China.

Leiophyllites admaris (Kiparisova)

Text-figure 49

Danubites (*Danubites*) *admaris* Kiparisova, 1961: 142, pl. 28, fig. 11, text-fig. 106.

Danubites (*Danubites*) aff. *floriani* Mojsisovics,—Kiparisova, 1961: 141, pl. 28, fig. 10, text-fig. 105.

Danubites (*Danubites*?) *incertus* Kiparisova, 1961: 143, pl. 29, figs. 1, 2, text-figs. 107, 108.

The assignment of these species and *maritimus* to *Leiophyllites* is done entirely on the basis of the suture pattern (Fig. 49). The ornamentation of these species and especially that of *maritimus* would ally these species to *Preflorianites*. In the interpretation followed here the suture is considered the more critical sign post of genetic affinity and the ornamentation a case of homeomorphy. The different species brought together here differ mainly in the degree of ribbing.

Occurrence. *Subcolumbites* fauna, Primorye Region, Siberia.

Leiophyllites maritimus (Kiparisova)

Text-figure 49

Preflorianites maritimus Kiparisova, 1958b: pl. 8, fig. 3, text-fig. 22b.

Danubites (*Preflorianites*) *maritimus* Kiparisova, 1961: 146, pl. 29, figs. 8, 9, text-fig. 111.

Danubites (*Preflorianites*) *inflatus* Kiparisova, 1961: 145, pl. 29, figs. 3, 4, text-figs. 109-110.

Danubites (*Preflorianites*) aff. *maritimus* Kiparisova, 1961: 147, pl. 29, fig. 10, text-fig. 112.

This species has a suture (Fig. 49D) much like that of *L. admaris* but the rib pattern is completely preflorianitid in aspect, that is, concentrated near the umbilical shoulder. The specimen from an upper Scythian horizon in the Toad Formation of British Columbia that Tozer (1965a: 40) assigned to *Leiophyllites* sp. indet. is quite similar to *L. maritimus*.

Occurrence. *Subcolumbites* fauna, Primorye Region, Siberia.

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PLATE 1. SUBCOLUMBITES PERRINISMITHI

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All specimens are from the *Subcolumbites* fauna of Kçira, Albania, and are deposited in the Paleontological Institute, Vienna.

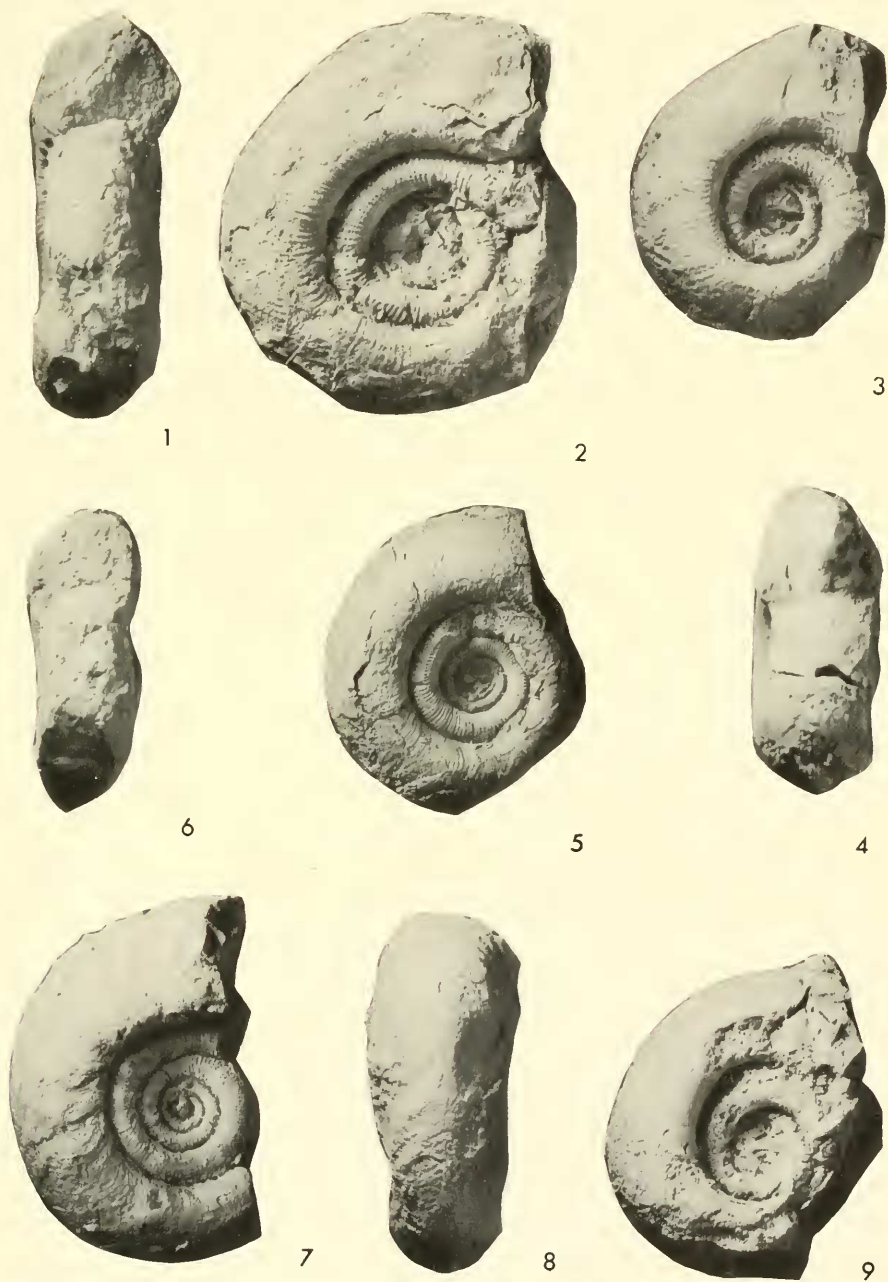


Plate 1

PLATE 2. SUBCOLUMBITES and ARIANITES

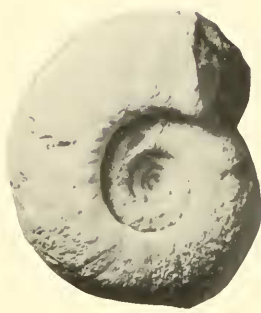
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All specimens are from the <i>Subcolumbites</i> fauna of Këira, Albania, and are deposited in the Paleontological Institute, Vienna.	



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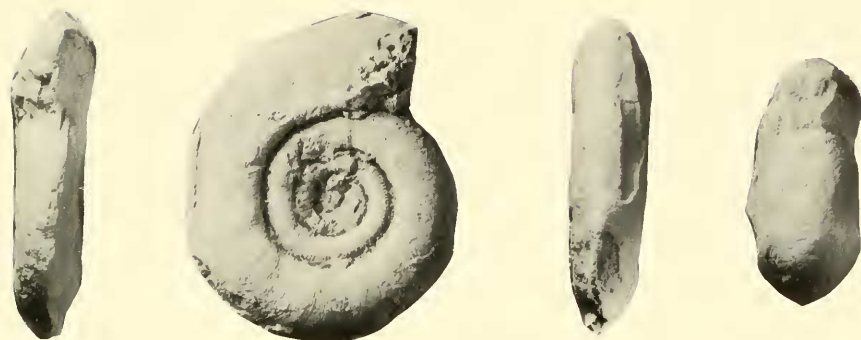
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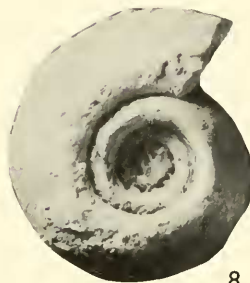
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All specimens are from the *Subcolumbites* fauna of Kçira, Albania, and are deposited in the Paleontological Institute, Vienna.

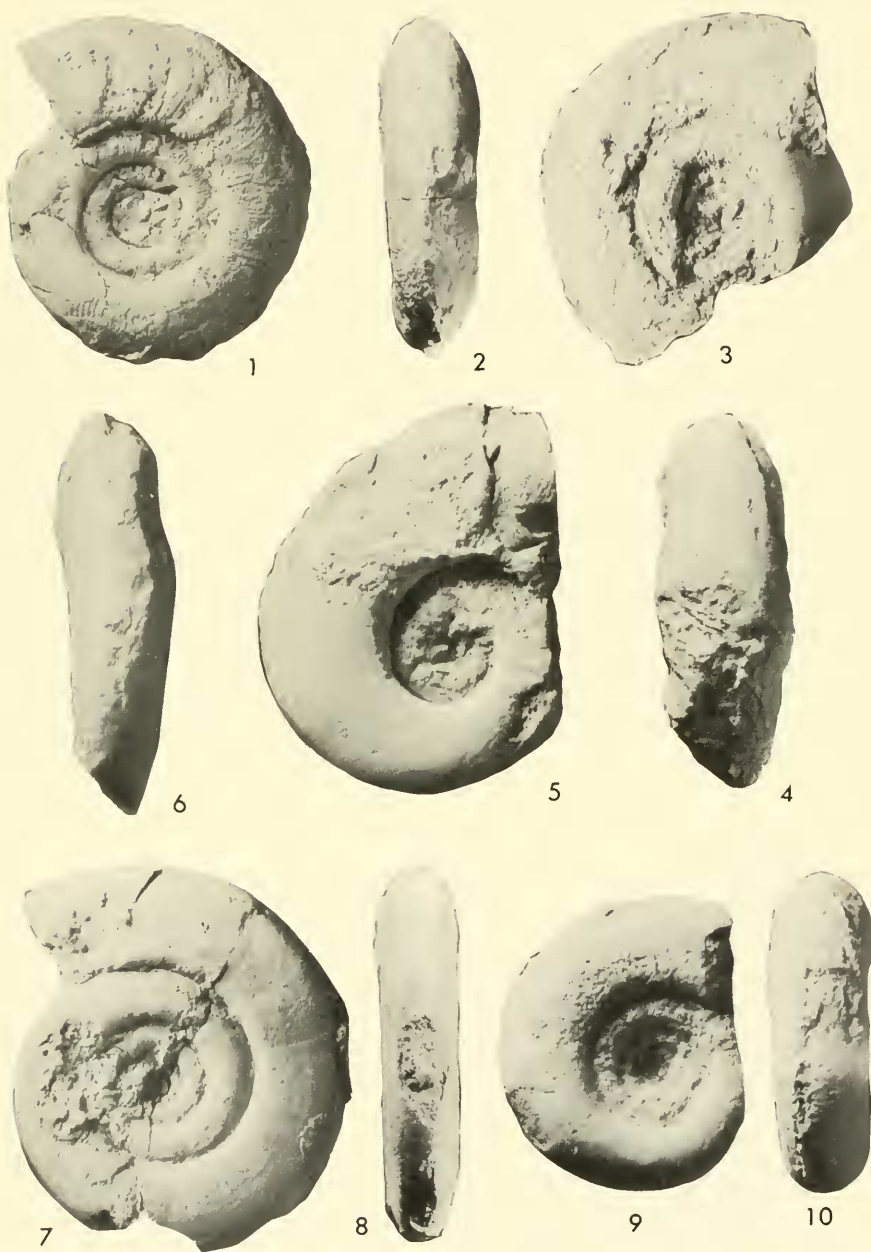


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All specimens are from the *Subcalumbites* fauna of Kçira, Albania, and are deposited in the Paleontological Institute, Vienna.

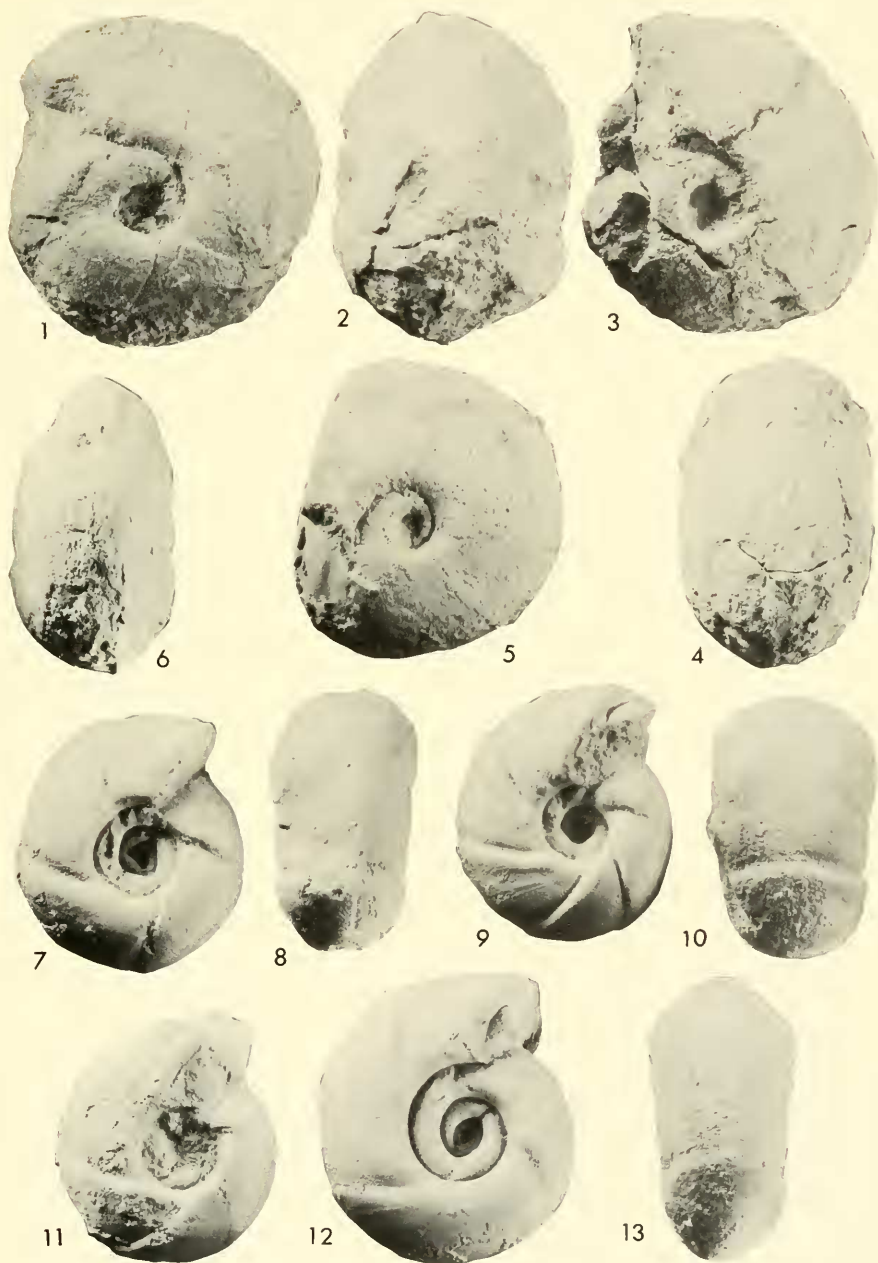


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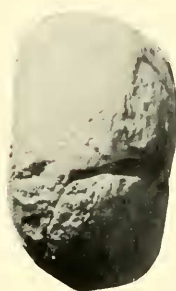
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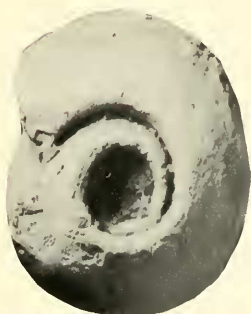
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Both specimens are from the *Subcolumbites* fauna of Kçira, Albania, and are deposited in the Paleontological Institute, Vienna.



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Both specimens are from the *Subcolumbites* fauna of Kçira, Albania, and are deposited in the Paleontological Institute, Vienna.



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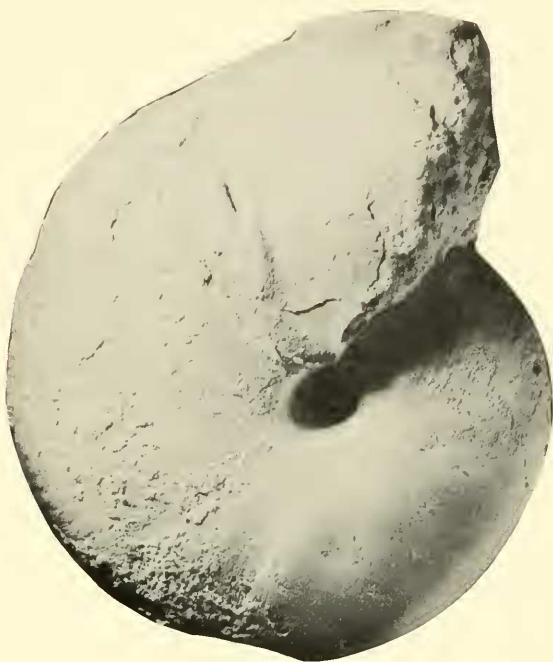
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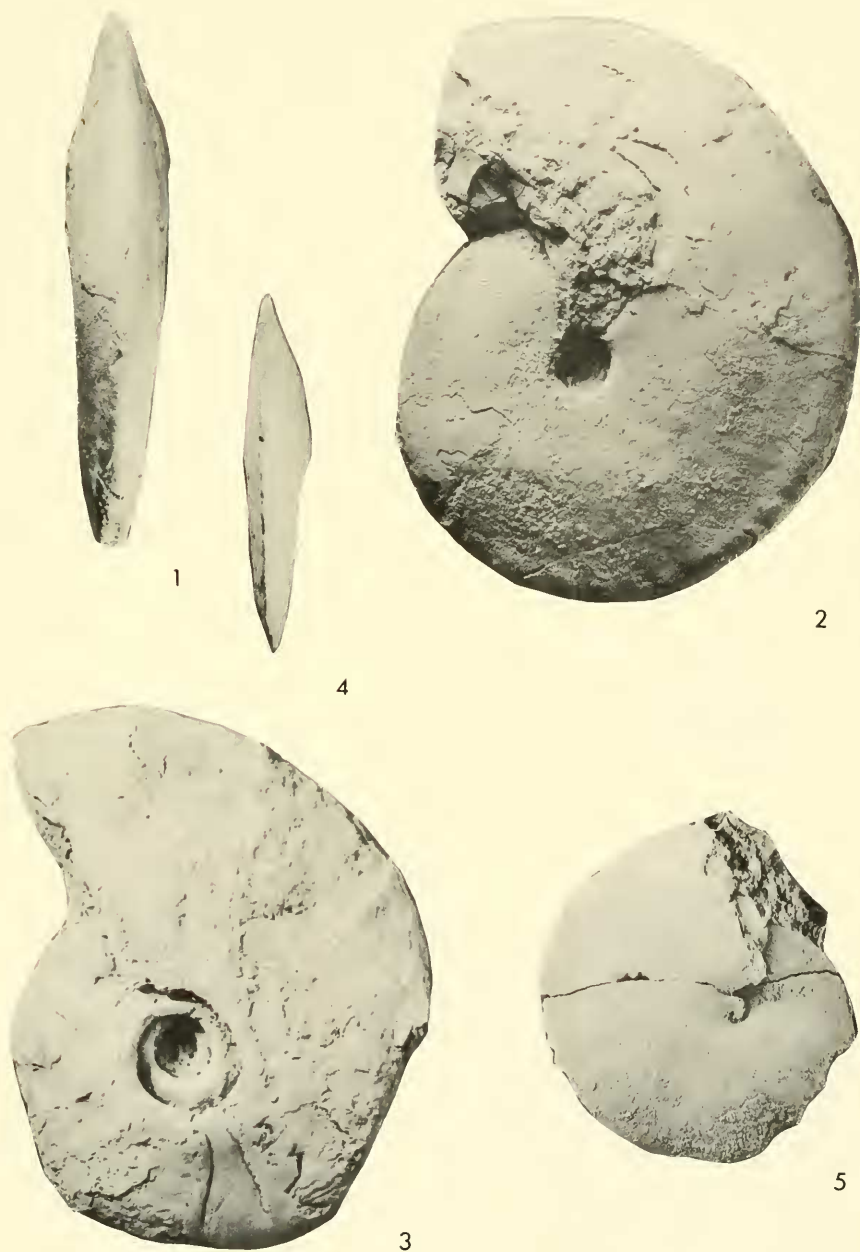


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All specimens are from the Subcolumbites fauna of Këira, Albania, and are deposited in the Paleontological Institute, Vienna.



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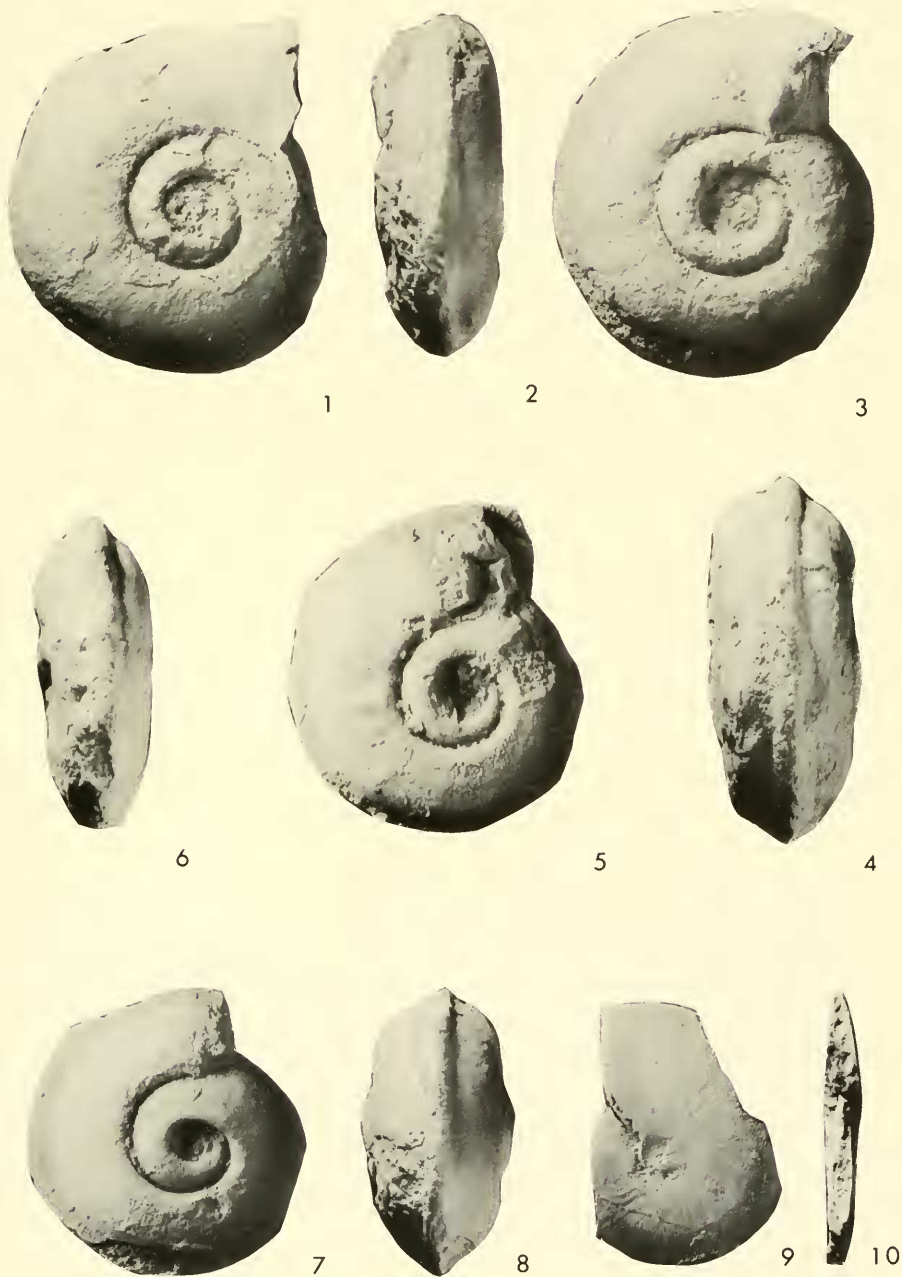


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All specimens are from the <i>Subcolumbites</i> fauna of Kçira, Albania, and are deposited in the Paleontological Institute, Vienna.	

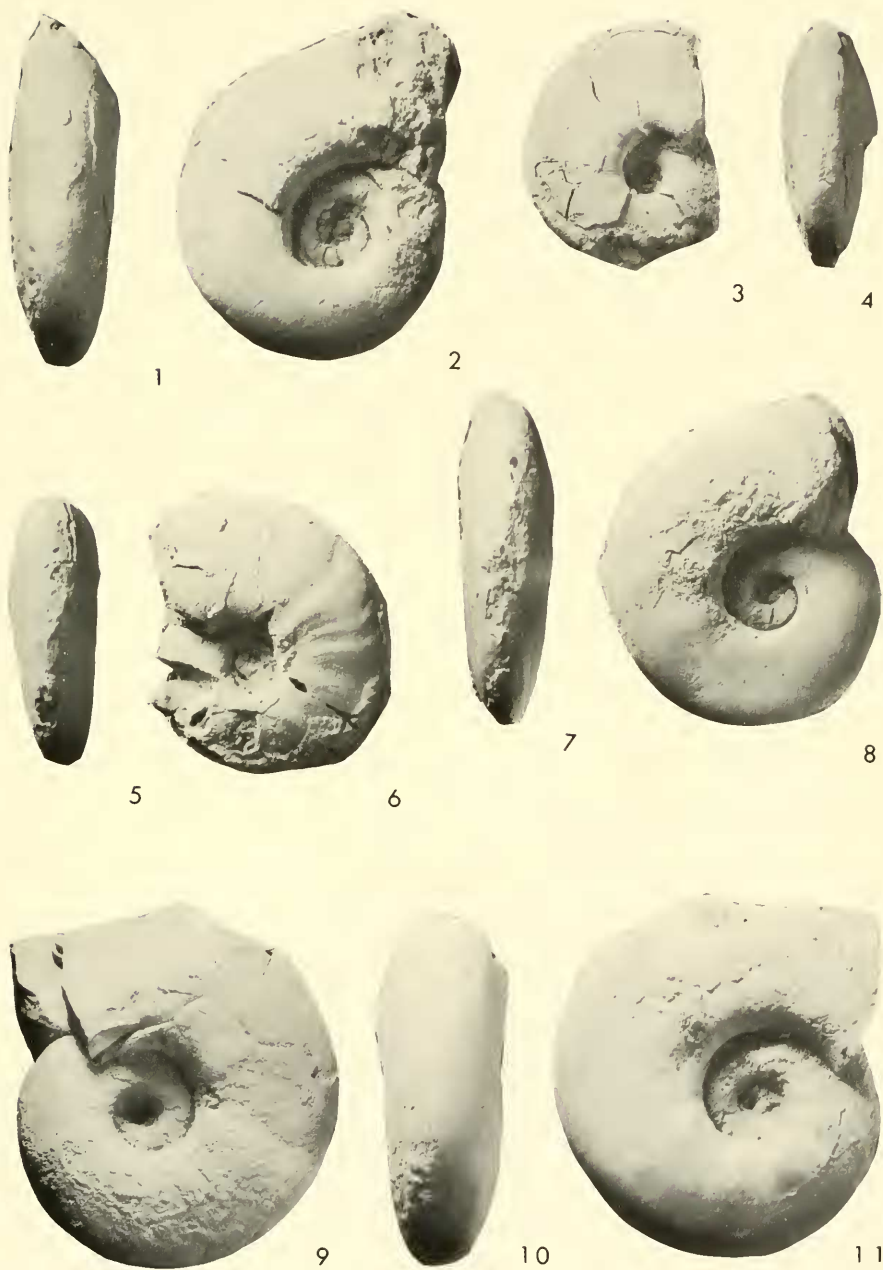


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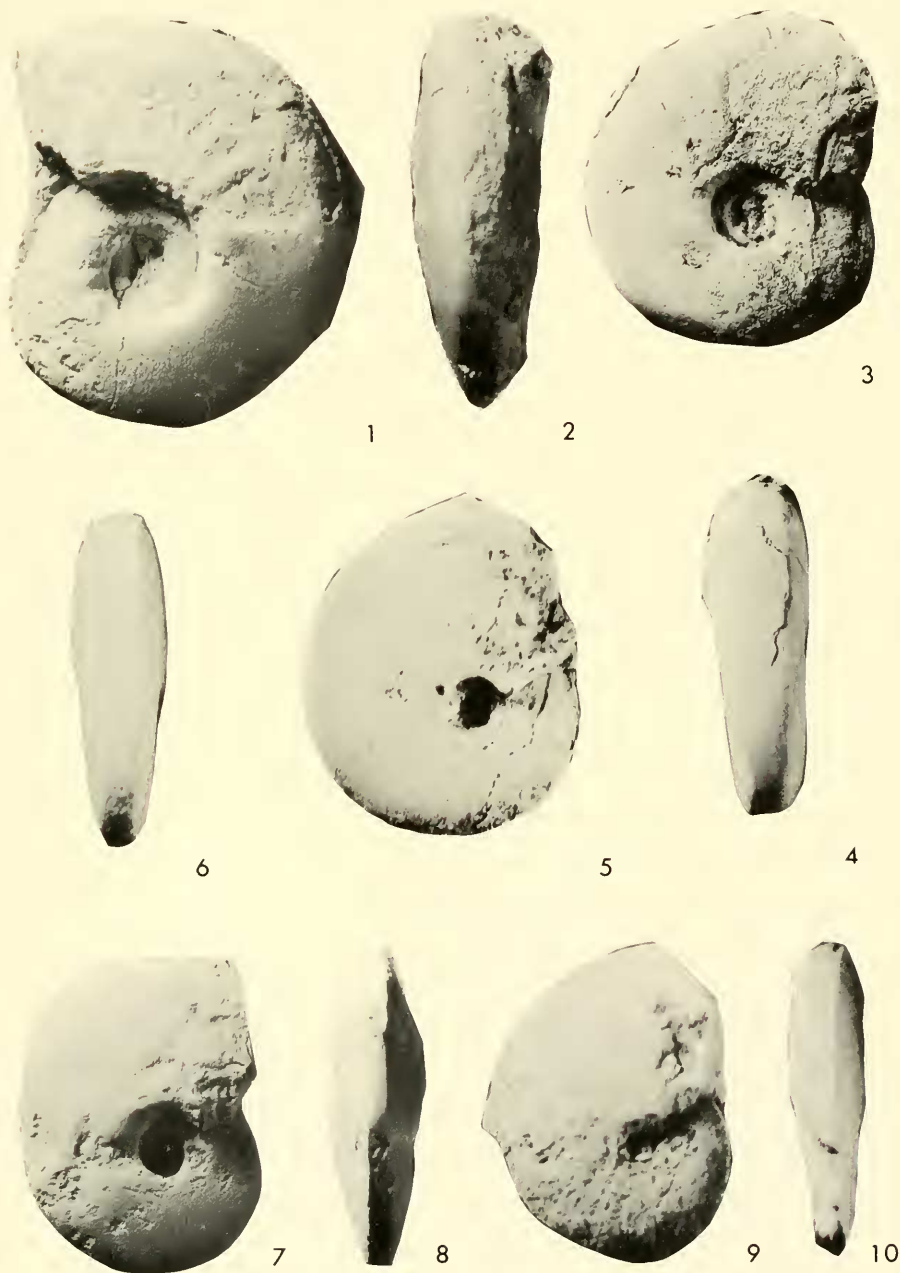


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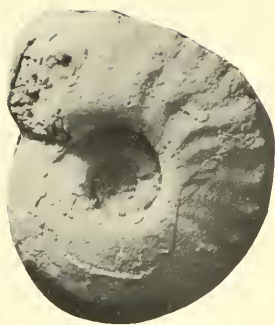
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All specimens are from the *Subcolumbites* fauna of Kçira, Albania, and are deposited in the Paleontological Institute, Vienna.



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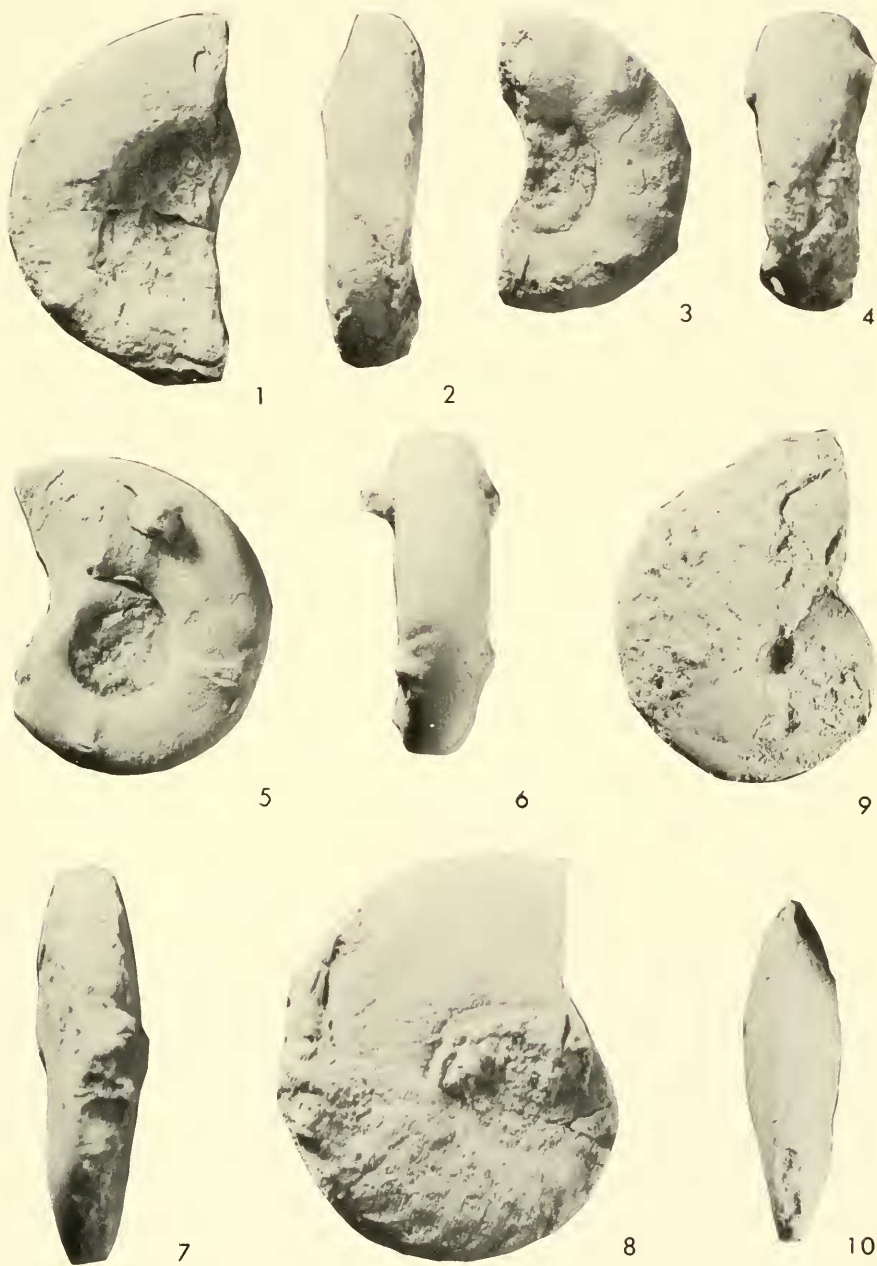


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	All specimens are from the Subcolumbites fauna of Kçira, Albania, and are deposited in the Paleontological Institute, Vienna.	

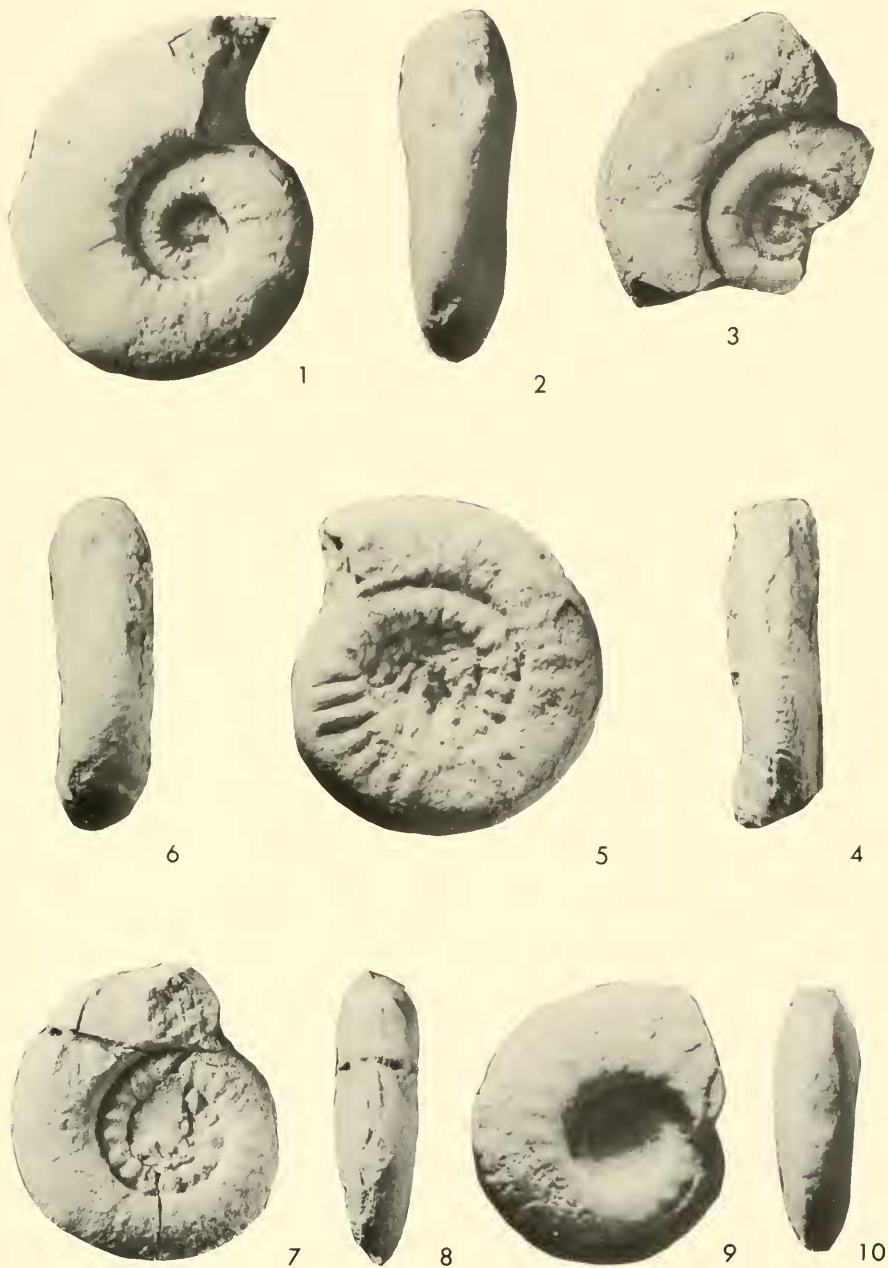


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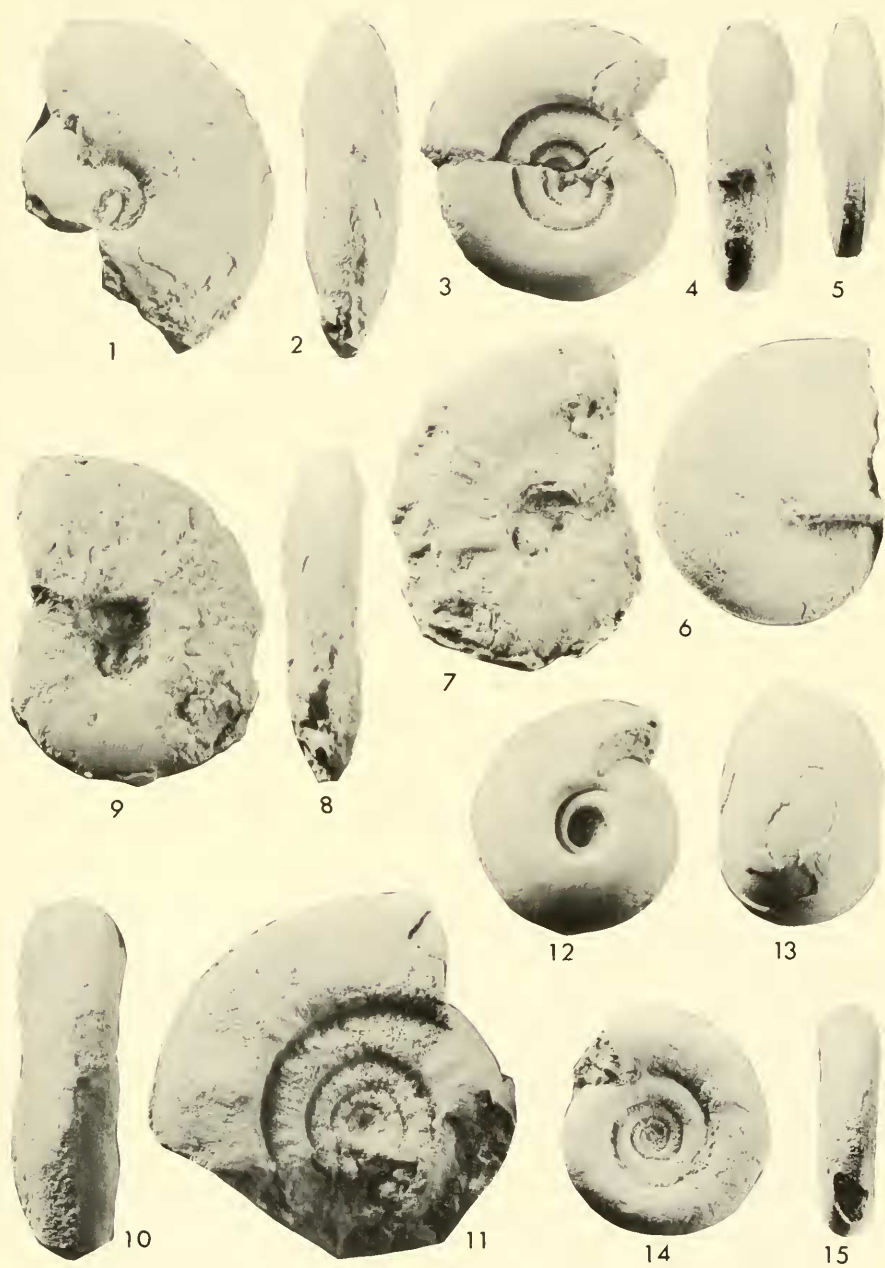


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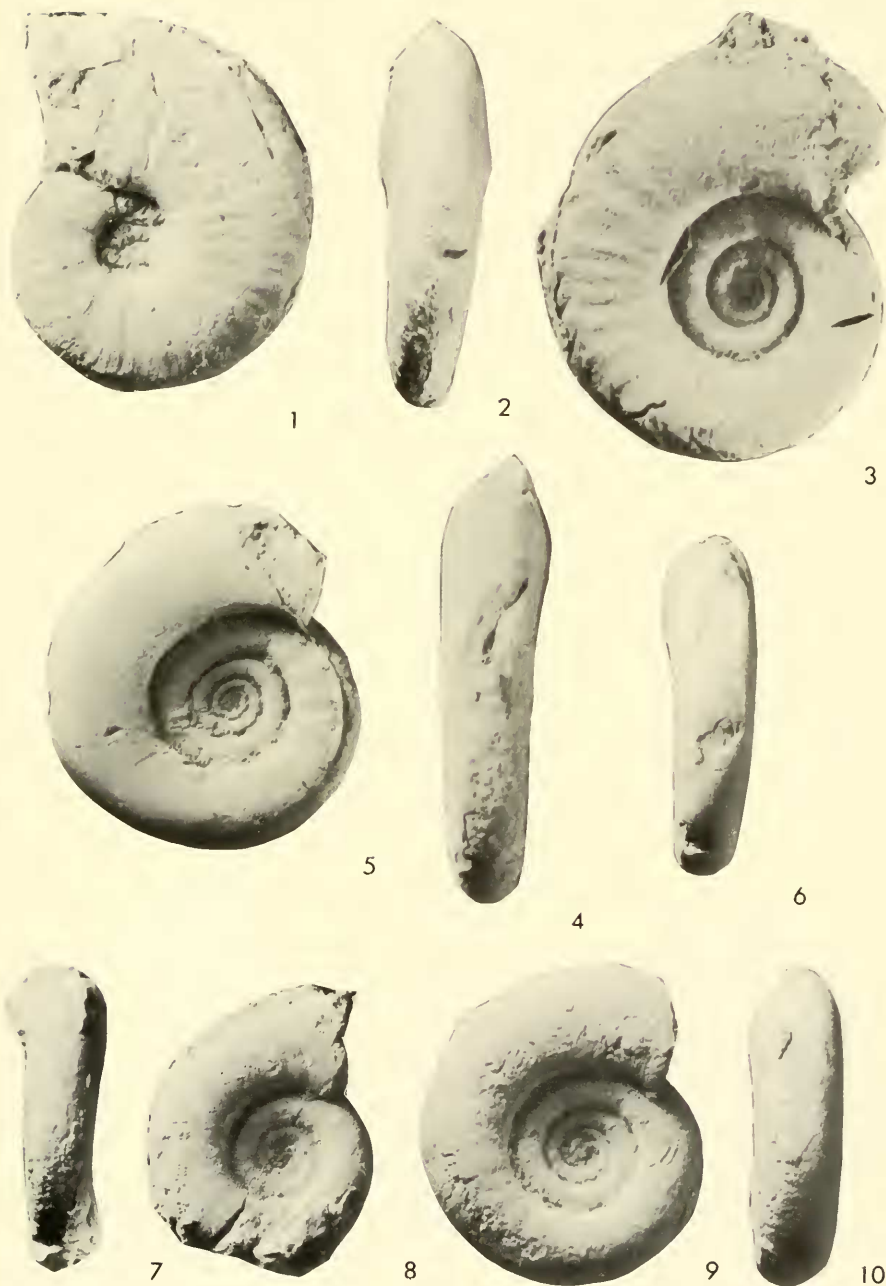


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4, 5	<i>Dagnoceras zappanense</i> Arthaber Side and ventral view of specimen from Nifoekoko, Timor. BMNH C33713, $\times$ 2.	459
6-9	<i>Sibirites renzi</i> n. sp. Side and ventral view of two paratypes, Figs. 6, 7, NHMB J19551, $\times$ 5; Figs. 8, 9 NHMB J19552, $\times$ 5 from Moradovuno, Chios.	483



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Plate 24

PLATE 25. PROPTYCHITOIDES, PROHUNGARITES, and HEMILECANITES

Figures		Page
1, 2	<i>Proptychitoides arthaberi</i> (Welter)	390
	Ventral and side view of manganese coated specimen, presumably same age as fauna from block E at Nifoekoko, Timor, $\times 1$.	
3-8	<i>Prahungarites middlemissii</i> (Diener)	520
	Figs. 3, 4, side and ventral view of syntype (Diener, 1913: fig. 6) GSI 11277, $\times 1$. Figs. 5, 6, side and ventral view of syntype (Diener, 1913: fig. 5) GSI 11277, $\times 1$. Figs. 7, 8, side and ventral view of syntype (Diener, 1913: fig. 7) GSI 11278, $\times 2$. Specimens from loose block, Postannah, Kashmir.	
9, 10	<i>Hemilecanites discus</i> (Arthaber)	374
	Side and ventral view of specimen from Subcolumbites fauna of Chios, NHMB J13703, $\times 1.5$.	



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PLATE 26. SVALBARDICERAS, KEYSERLINGITES, and PROSPHINGITES

Figures	Page
1-4 <i>Svalbardiceras spitzbergensis</i> (Frebold) Figs. 1, 2, plesiotype (= <i>Ammonites</i> sp. indet. Frebold, 1929b: pl. 1, fig. 12), $\times$ 1. Figs. 3, 4, plesiotype (= <i>Ammonites</i> sp. indet. Frebold, 1929b: pl. 1, fig. 13), $\times$ 1.	450
5 <i>Svalbardiceras schmidtii</i> (Mojsisovics) Side view of <i>Meekoceras</i> sp. indet. Frebold (1929b: pl. 1, fig. 11), $\times$ 1.	451
6, 7 <i>Keyserlingites subrobustus</i> (Mojsisovics) Fig. 6, side view of specimen figured by Frebold (1929b: pl. 2, fig. 9), $\times$ 1. Fig. 7, side view of specimen figured by Frebold (1929b: pl. 2, fig. 8), $\times$ 1.	485
8 <i>Prospingites czekonowskii</i> Mojsisovics Topotype specimen, MCZ 8677, $\times$ 1.5. Specimens of Figures 1-7 are from upper Scythian horizon of Cape Thorson, Isfjord, Spitsbergen; specimen of Figure 8 is from the mouth of the Olenek River, Siberia.	405

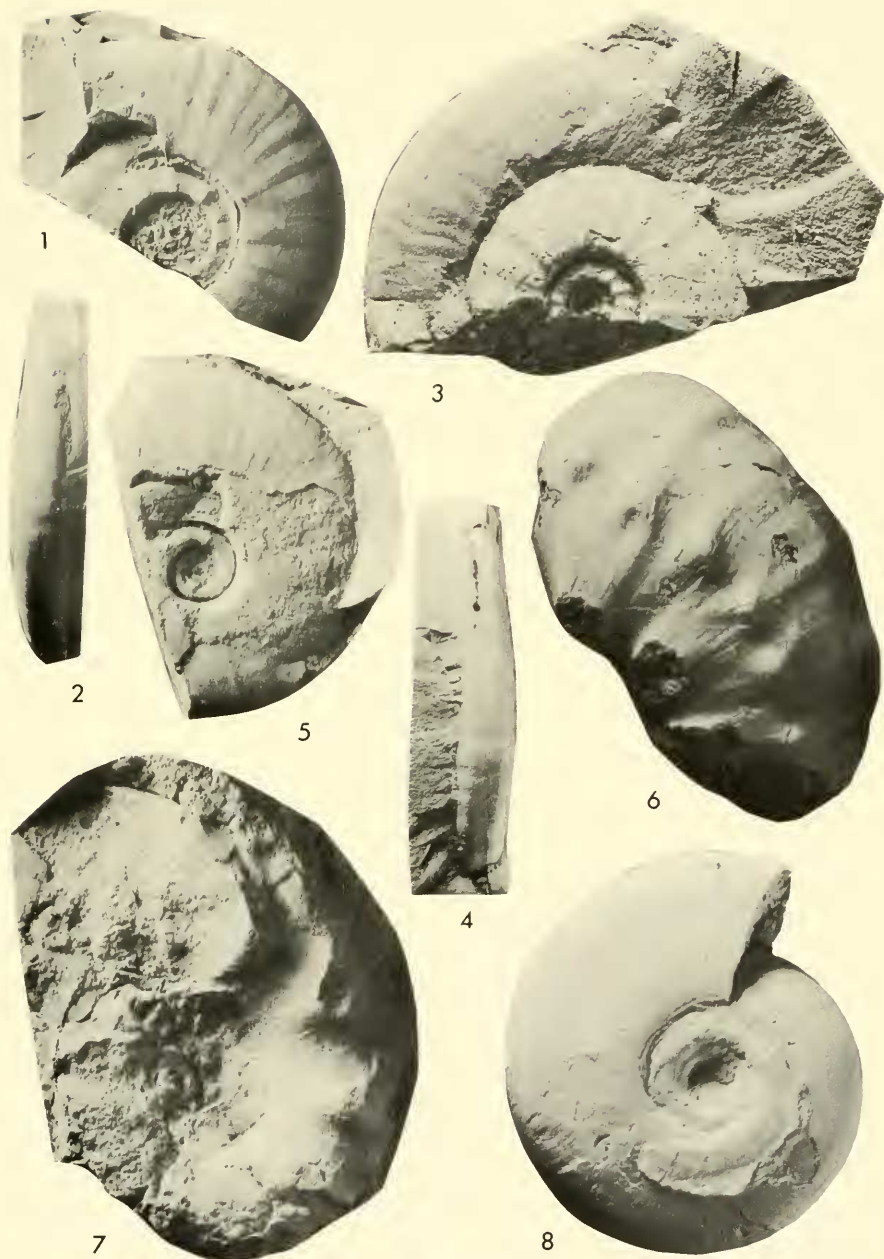


Plate 26

PLATE 27. METADAGNOCERAS and PSEUDOCELITITES

Figures		Page
1-4	<i>Metadagnoceras tabini</i> n. sp. Figs. 1, 2, side and ventral view of paratype, MCZ 9638, $\times 1$. Fig. 3, holotype, MCZ 9637, $\times 1$. Fig. 4, paratype, MCZ 9639, $\times 1$.	461
5-10	<i>Pseudocelinites multiplicatus</i> (Waagen) Figs. 5, 6, side and ventral view of holotype of <i>Celinites multiplicatus</i> Waagen (1895: pl. 7, figs. 2a-c), GSI 7062, $\times 1$. Figs. 7, 8, side and ventral view of syntype of <i>Celinites armatus</i> Waagen (1895: pl. 7, figs. 1a-c), GSI 7061, $\times 1$. Figs. 9, 10, side and ventral view of syntype of <i>Celinites armatus</i> Waagen (1895: pl. 7, figs. 7a-c), GSI 7067, $\times 1.5$. Specimens of Figures 1-4 are from the Tabin Formation, Tabin Range, Nevada; specimens of Figures 5-10 are from the Mianwali Formation, Salt Range, West Pakistan.	440



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PLATE 28. STACHEITES FLOWERI

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1-10 *Stacheites floweri* n. sp.

Fig. 1, paratype, MCZ 9439, $\times 1$. Fig. 2, paratype, MCZ 9440, $\times 1$. Figs. 3, 4, holotype, MCZ 9441, $\times 1$.
Fig. 5, paratype, MCZ 9442, $\times 1$. Figs. 6, 7, paratype, MCZ 9443, $\times 1.5$. Fig. 8, paratype, MCZ 9444,
 $\times 1$. Fig. 9, paratype, MCZ 9445, $\times 1$. Fig. 10, paratype, MCZ 9446, $\times 1$.

All specimens are from the Tobin Formation, Tobin Range, Nevada.

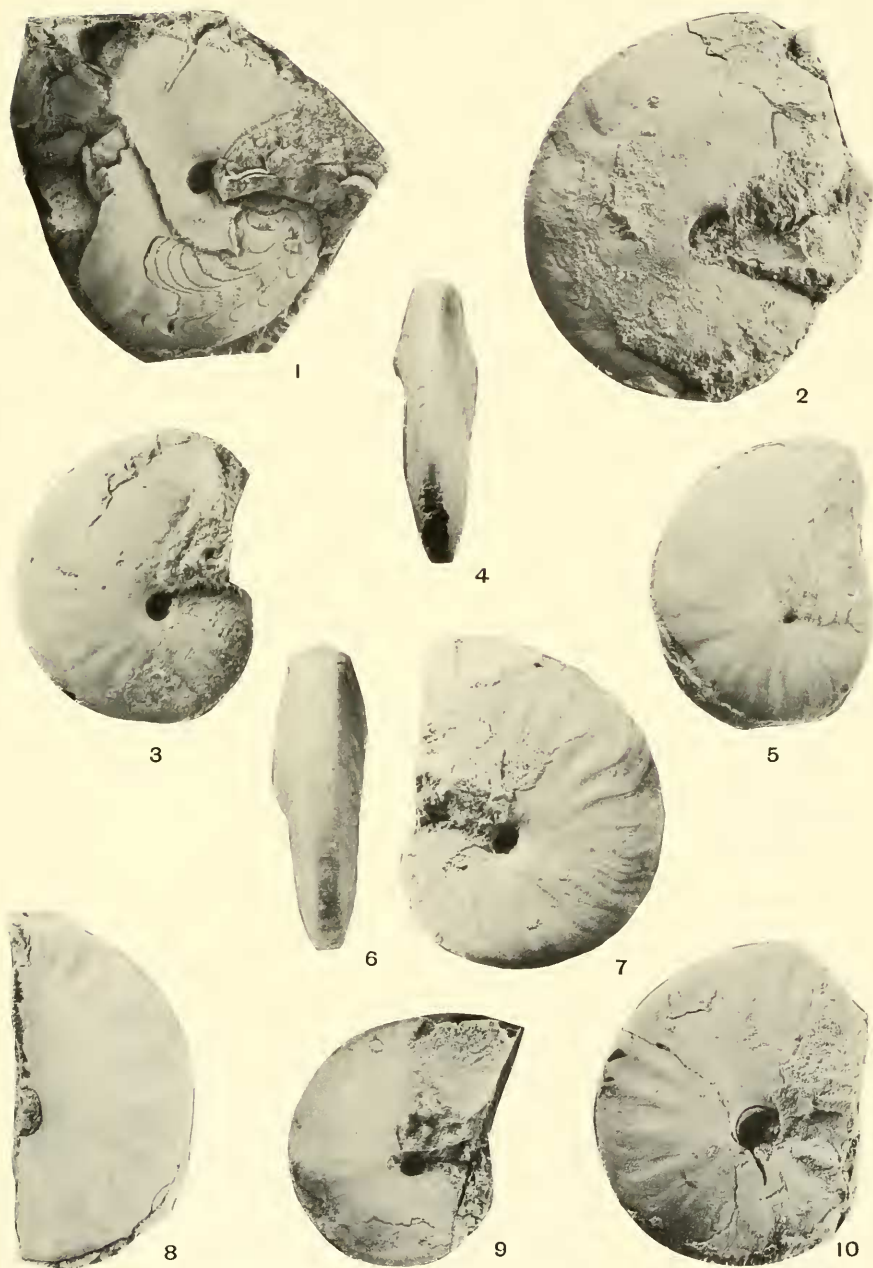


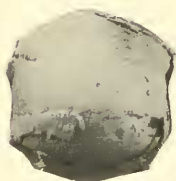
Plate 28

PLATE 29. ISCULITOIDES and HEMILECANITES

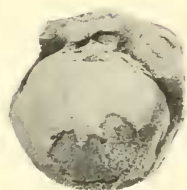
Figures		Page
1-10	<i>Isculitoides wasserbergi</i> n. sp. Figs. 1-3, holotype, MCZ 9447, $\times$ 1.5. Figs. 4-6, paratype, MCZ 9448, $\times$ 2. Figs. 7, 8, paratype, MCZ 9449, $\times$ 2. Figs. 9, 10, paratype, MCZ 9450, $\times$ 3.	418
11, 12	<i>Hemilecanites paradiscus</i> n. sp. Paratype, MCZ 9451, $\times$ 2.	375
All specimens are from the Tobin Formation, Tobin Range, Nevada.		



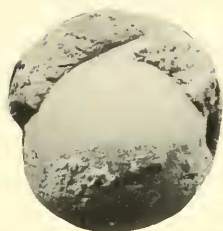
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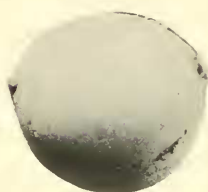
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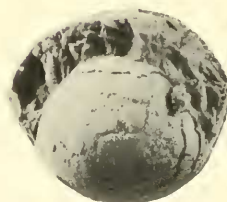
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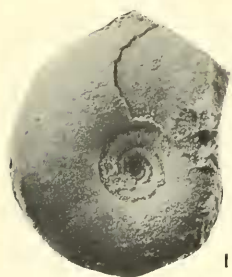
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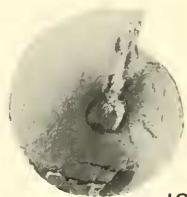
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PLATE 30. SUBCOLUMBITES AMERICANUS

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1-14 *Subcolumbites americanus* n. sp.

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Figs. 1, 2, holotype, MCZ 9430, $\times$ 1. Fig. 3, paratype, MCZ 9431, $\times$ 1. Fig. 4, paratype, MCZ 9432, $\times$ 1.5. Fig. 5, paratype, MCZ 9433, $\times$ 1. Figs. 6, 7, paratype, MCZ 9434, $\times$ 1. Fig. 8, paratype, MCZ 9435, $\times$ 1. Figs. 9, 10, paratype, MCZ 9436, $\times$ 1.5. Figs. 11, 12, paratype, MCZ 9437, $\times$ 1.5. Figs. 13, 14, paratype, MCZ 9438, $\times$ 1.5.

All specimens are from the Tobin Formation, Tobin Range, Nevada.

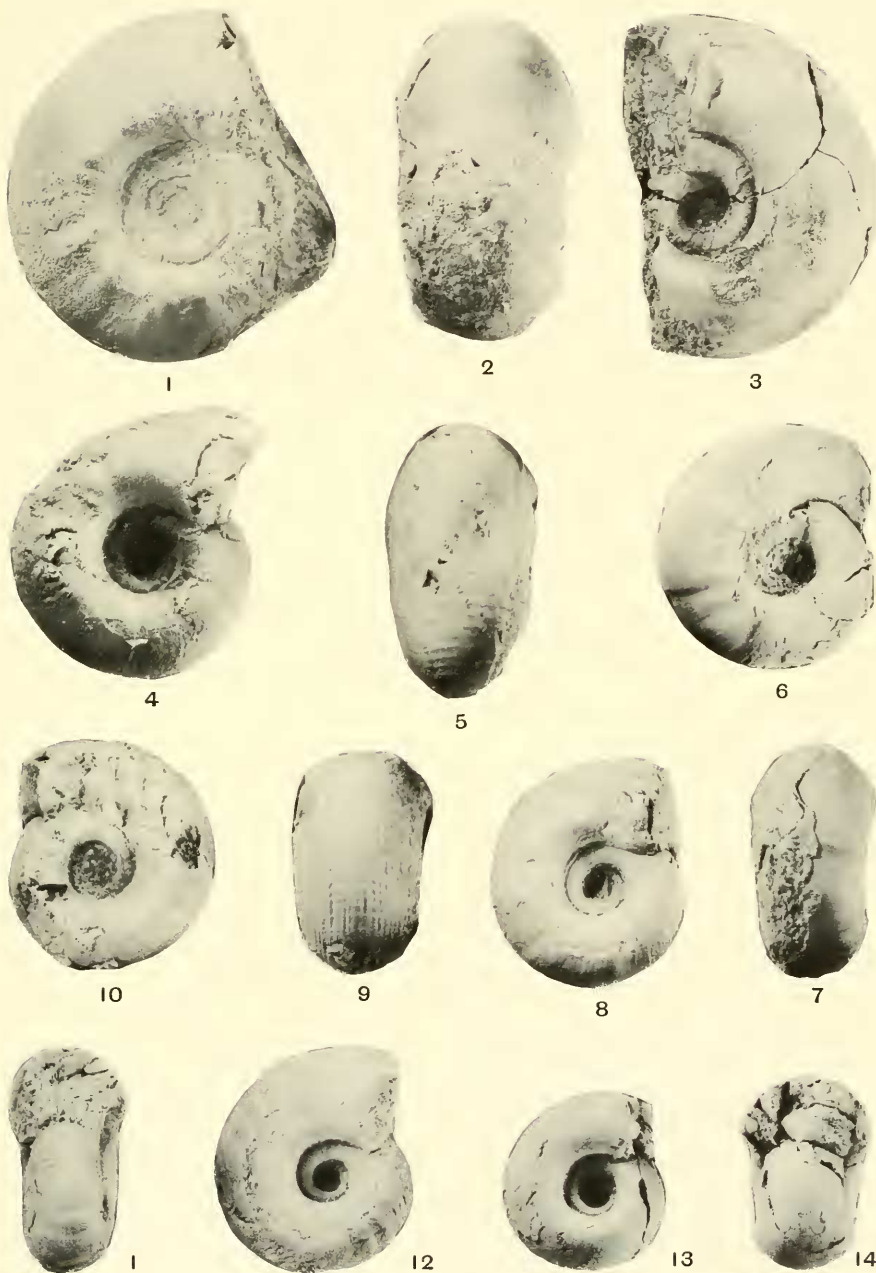


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PLATE 31. ARNAUTOCELTITES, USSURITES, and HEMILECANITES

Figures		Page
1-7,	<i>Arnautoceltites techerti</i> n. sp.	402
9, 10,		
13, 14	Figs. 1, 2, holotype, MCZ 9457, $\times$ 1.5. Figs. 3, 4, paratype, MCZ 9458, $\times$ 1.5. Fig. 5, paratype, MCZ 9459, $\times$ 1.5. Figs. 6, 7, paratype, MCZ 9460, $\times$ 1.5. Figs. 9, 10, paratype, MCZ 9461, $\times$ 1.5. Figs. 13, 14, paratype, MCZ 9462, $\times$ 1.5.	
8	<i>Ussurites sieveri</i> n. sp.	528
	Paratype, MCZ 9464, $\times$ 1.5.	
11, 12	<i>Subcolumbites americanus</i> n. sp.	436
	Paratype, MCZ 9463, $\times$ 1.	
15, 16	<i>Hemilecanites paradiscus</i> n. sp.	375
	Holotype, MCZ 9465, $\times$ 1.5.	
	All specimens are from the Tabin Formation, Tabin Range, Nevada.	

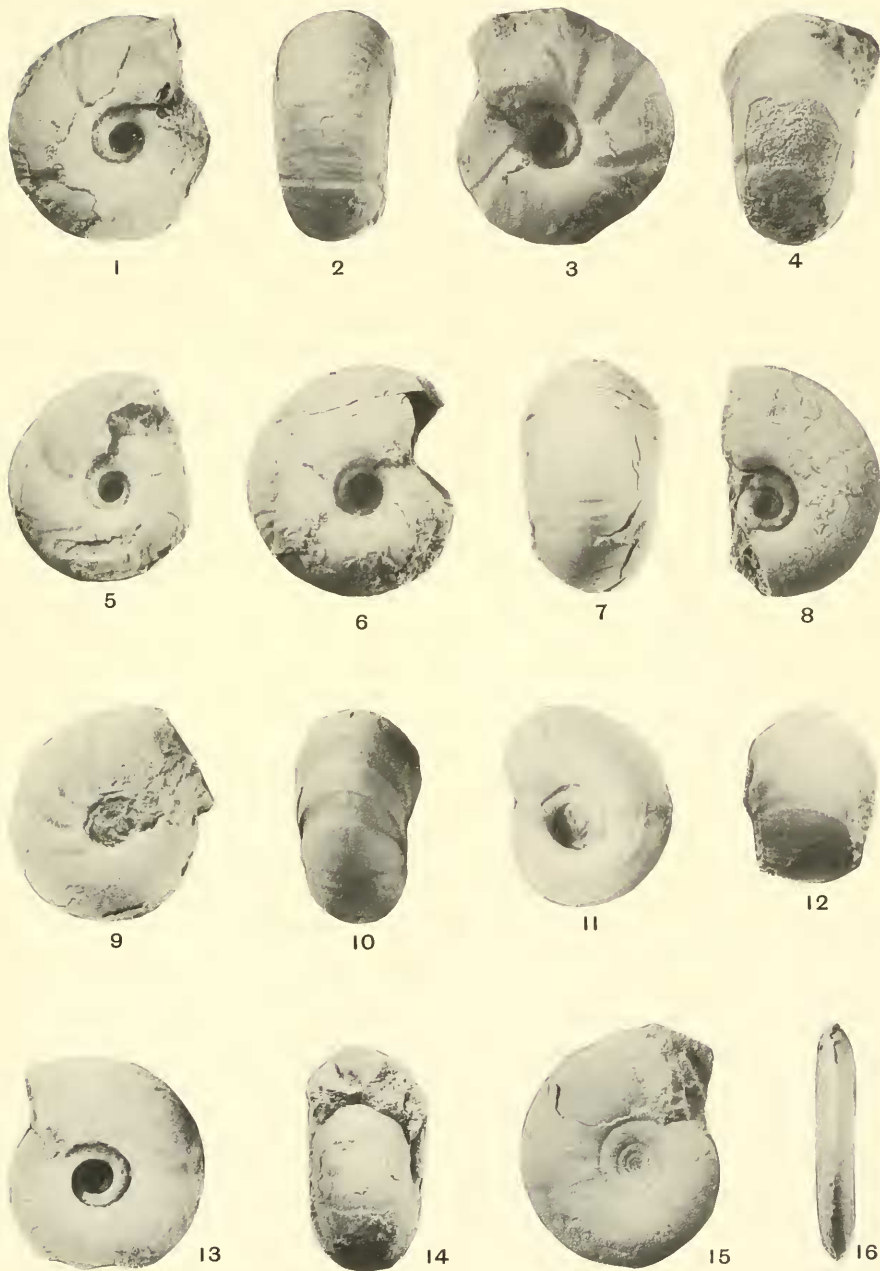


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PLATE 32. USSURITES SIEVERI

Figures		Page
1-7	<i>Ussurites sieveri</i> n. sp.	528
	Figs. 1, 2, holotype, MCZ 9452, $\times$ 1. Fig. 3, paratype, MCZ 9453, $\times$ 1. Fig. 4, paratype, MCZ 9454, $\times$ 1.	
	Fig. 5, paratype, MCZ 9455, $\times$ 1. Figs. 6, 7, paratype, MCZ 9456, $\times$ 1.	
	All specimens are from the Tobin Formation, Tobin Range, Nevada.	

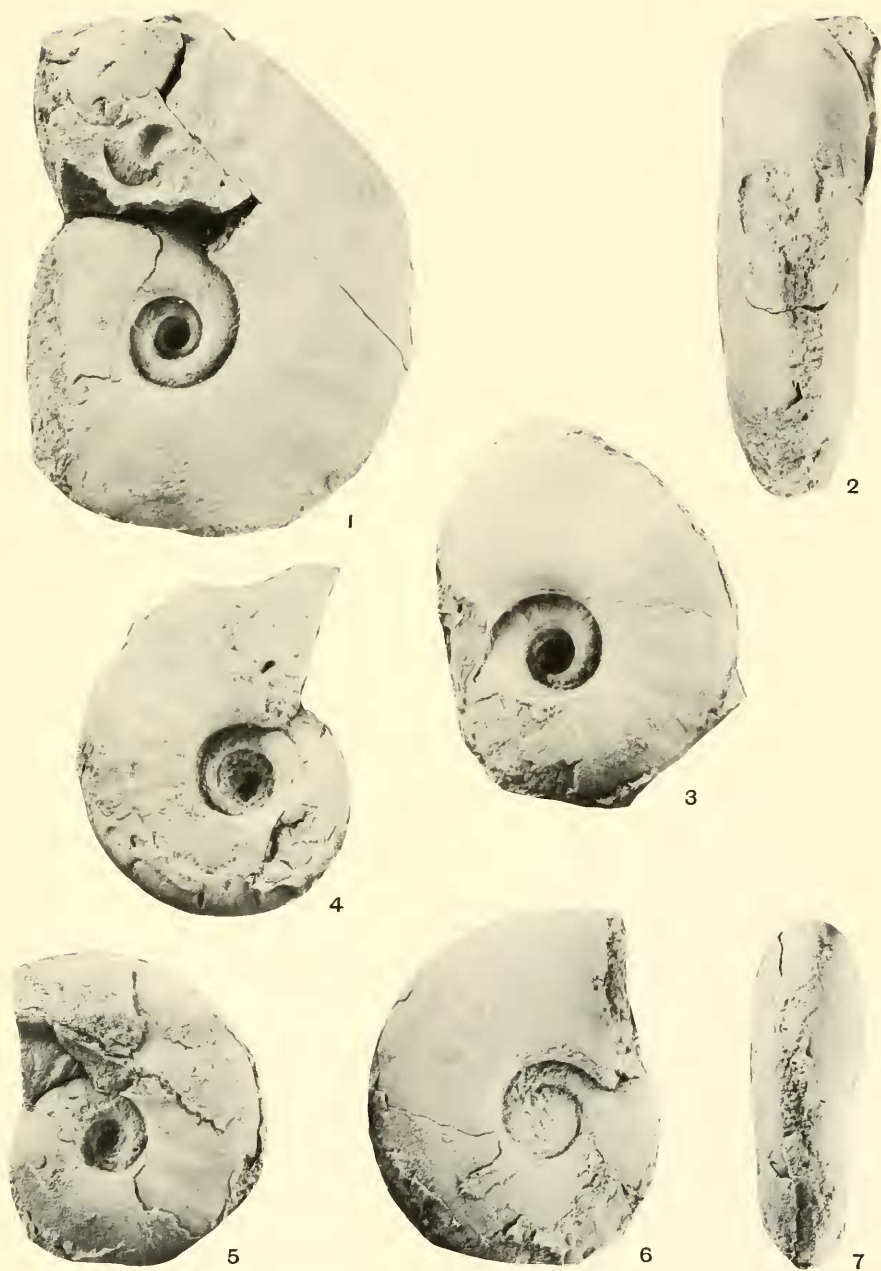


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PLATE 33. USSURITES HOSEI

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1-6 *Ussurites hosei* n. sp.

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Fig. 1, holotype, USNM 153085, $\times$ 1. Fig. 2, paratype, USNM 153086, $\times$ 2. Figs. 3, 4, paratype, USNM 153087, $\times$ 1. Figs. 5, 6, paratype, USNM 153088, $\times$ 1.

All specimens are from the USGS collection M111, Confusion Range, Utah. From section 15 of Hose and Repenning (1959).

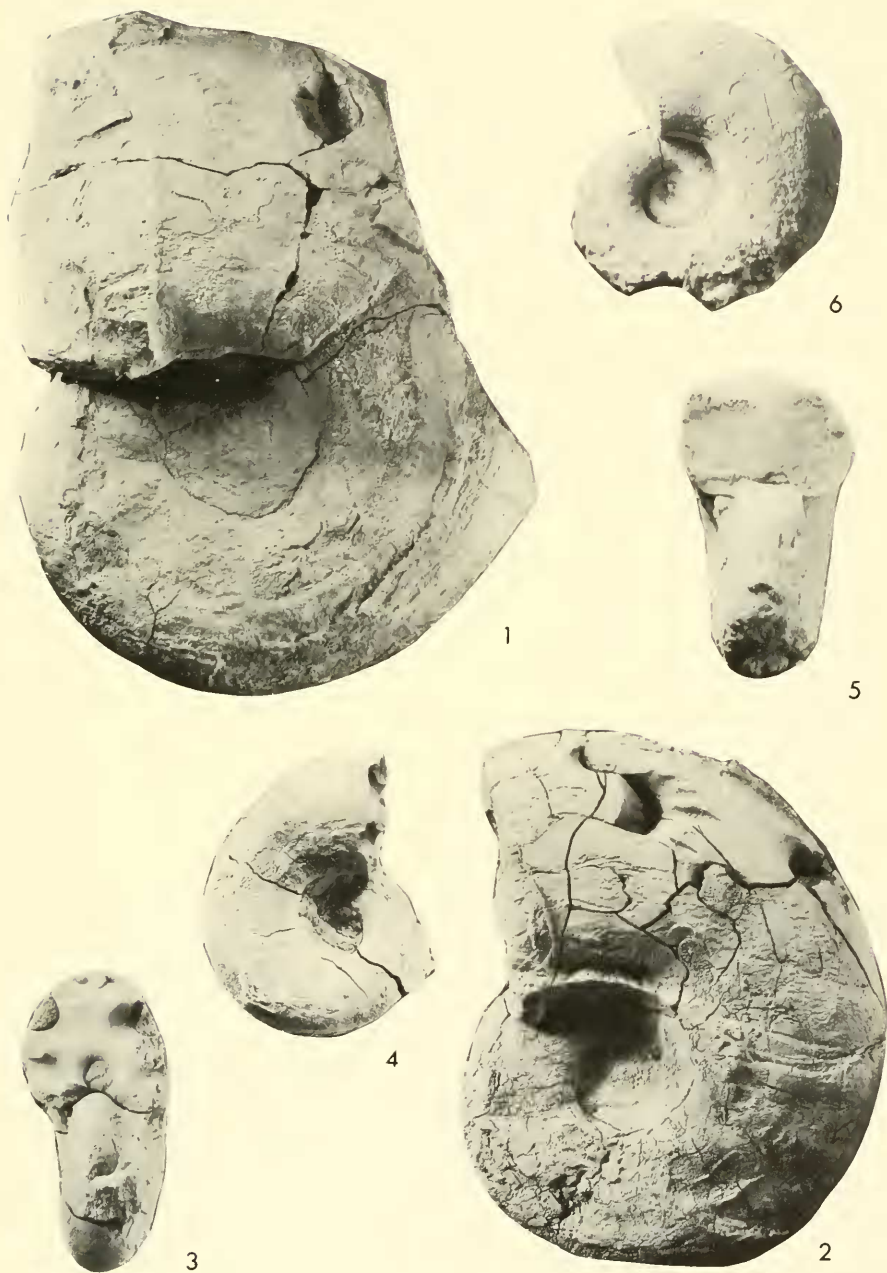


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PLATE 34. PSEUDOCELTITES, PSEUDOSAGECERAS, and TIROLITES

Figures	Page
1-5 <i>Pseudoceltites nevadi</i> n. sp. Fig. 1, side view of holotype, USNM 153078, $\times$ 1. Figs. 2, 3, side and ventral view of fragment of paratype, USNM 153079, $\times$ 1. Figs. 4, 5, side and ventral view of fragment of paratype, USNM 153080, $\times$ 1.	440
6 <i>Pseudosageceras multilabatum</i> Noetting Side view, USNM 153072, $\times$ 1.	361
7-10 <i>Tirolites</i> cf. <i>cassionus</i> (Qunstedt) Figs. 7, 8, side and ventral view of portion of body chamber, USNM 153083, $\times$ 1. Figs. 9, 10, side and ventral view of fragmentary specimen, USNM 153084, $\times$ 1. All specimens are from the USGS Collection M111, Thaynes Formation, Confusion Range, Utah, associated with <i>Ussurites hasei</i> n. sp.	503



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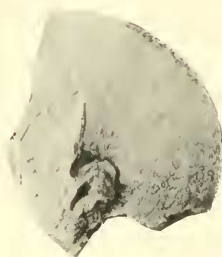
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PLATE 35. PROHUNGARITES, EPICELTITES, USSURITES, and HEMILECANITES

Figures		Page
1-5, 8, 9	<i>Prohungarites mckelveyi</i> n. sp. Figs. 1, 2, holotype, MCZ 9466, $\times$ 1. Figs. 3, 4, paratype, MCZ 9467, $\times$ 1.5. Fig. 5, paratype, MCZ 9468, $\times$ 1.5. Figs. 8, 9, paratype, MCZ 9469, $\times$ 1.	520
6, 7	<i>Epiceltites gentii</i> (Arthaber) Fig. 6, plesiotype, MCZ 9470, $\times$ 1.5. Fig. 7, plesiotype, MCZ 9471, $\times$ 1.5.	447
10, 11	<i>Ussurites sieveri</i> n. sp. Paratype, MCZ 9472, $\times$ 1.5.	528
12	<i>Hemilecanites paradiscus</i> n. sp. Paratype, MCZ 9473, $\times$ 1.5.	375

Figures 1-9 are from the upper member of Thaynes Formation, Hammond Creek, Bear River Range, south-east Idaho. Figures 10-12 are from Tobin Formation, Tobin Range, Nevada.

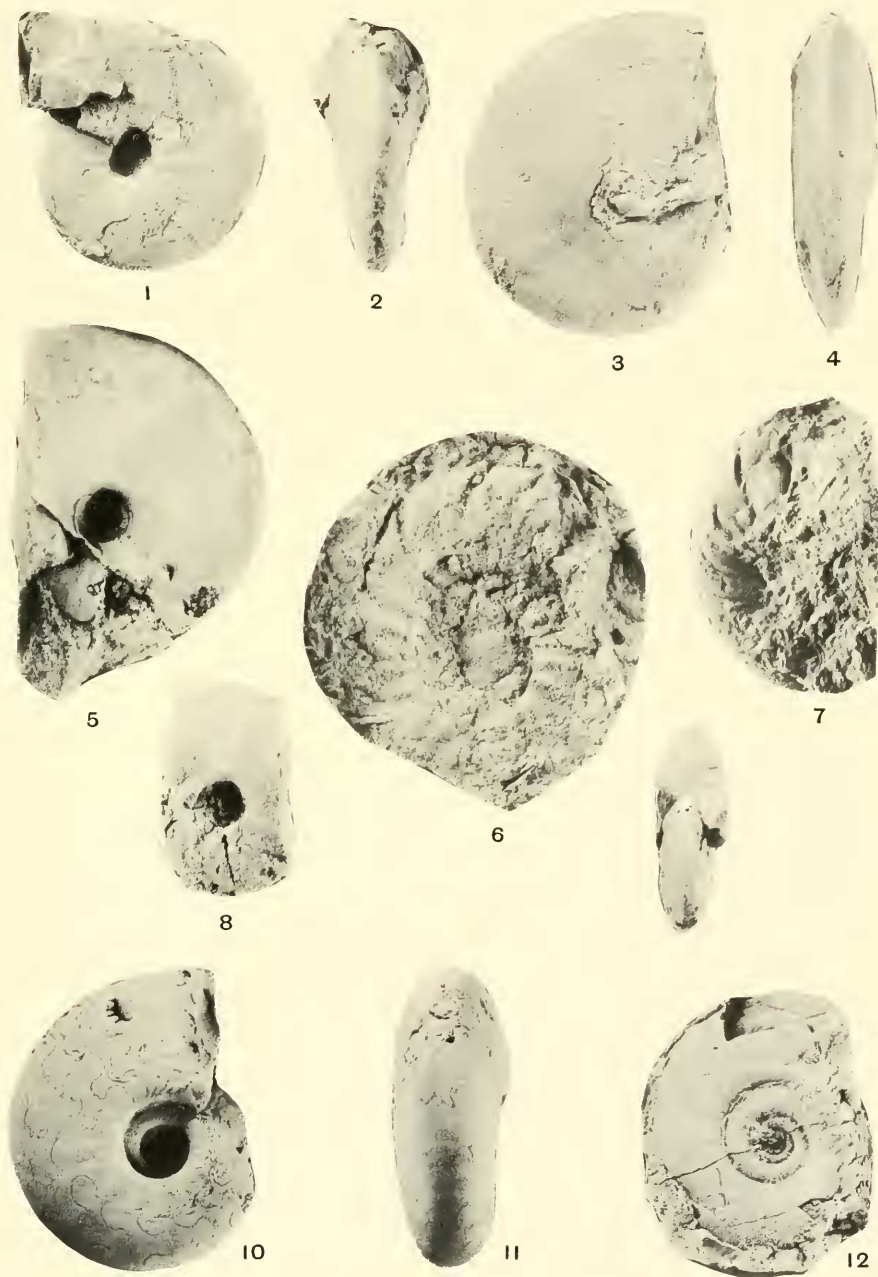


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PLATE 36. *PROHUNGARITES*, *OLENEKITES*, and *ISCVLITOIDES*

Figures		Page
1, 2	<i>Prahungarites</i> sp. indet. MCZ 9474, $\times$ 1.	522
3	<i>Prahungarites gutstadti</i> n. sp. Side view of holotype, MCZ 9475, $\times$ 1.	521
4-7	<i>Olenekites</i> cf. <i>spiniplicatus</i> (Majsisovics) Figs. 4, 5, plesiatype, MCZ 9482, $\times$ 1.5. Figs. 6, 7, plesiatype, MCZ 9476, $\times$ 1.5.	489
8-13	<i>Isculitoides hammondi</i> n. sp. Fig. 8, holotype, MCZ 9477, $\times$ 1.5. Figs. 9, 10, paratype, MCZ 9478, $\times$ 1.5. Fig. 11, paratype, MCZ 9479, $\times$ 1.5. Figs. 12, 13, paratype, MCZ 9480, $\times$ 1.5.	419
14, 15	<i>Prahungarites gutstadti</i> n. sp. Side and ventral view of paratype, MCZ 9481, $\times$ 2. All specimens are from the upper member of Thaynes Formation, Hammond Creek, Bear River Range, south-east Idaho.	521

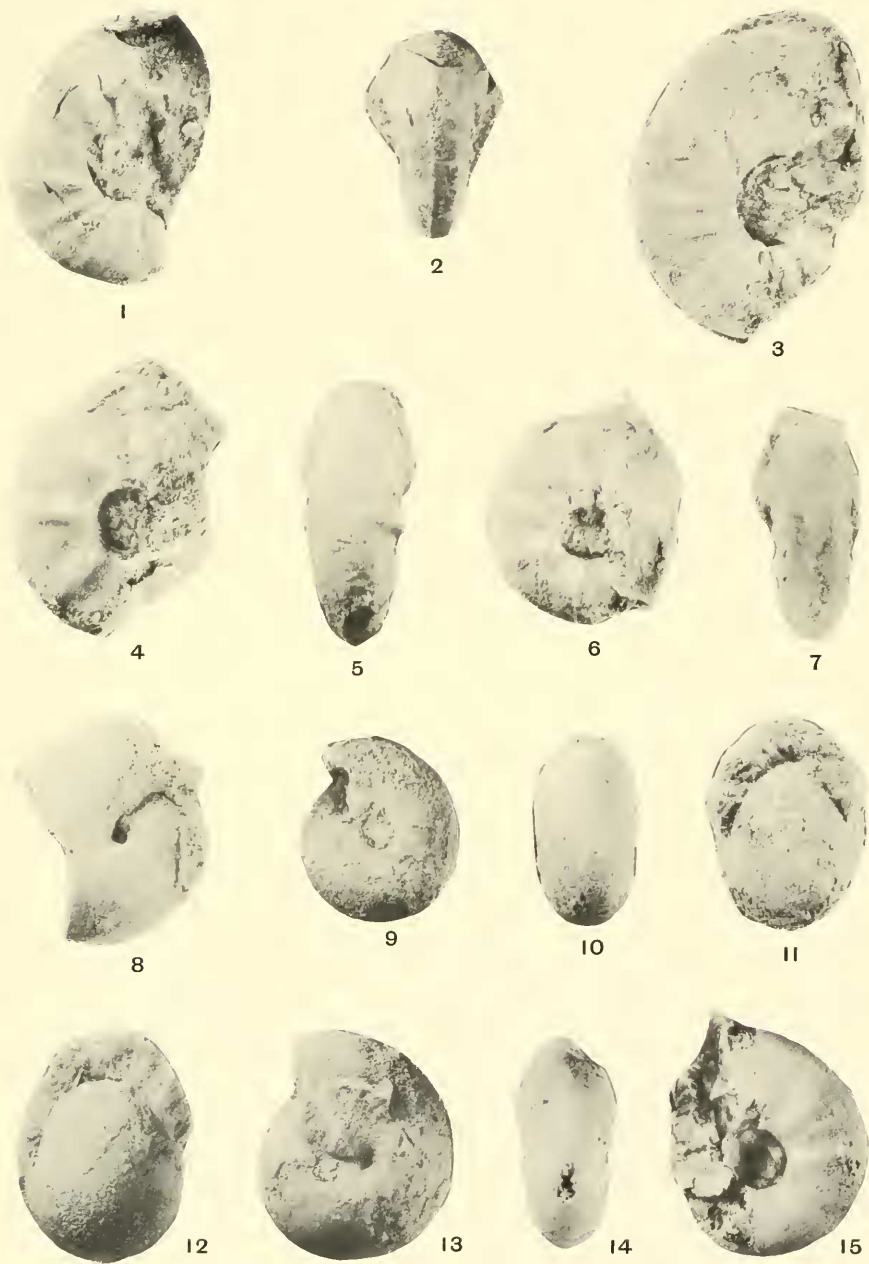


Plate 36

PLATE 37. KEYSERLINGITES and STACHEITES

Figures	Page
1-4 <i>Keyserlingites bearriverensis</i> n. sp. Figs. 1, 2, side and ventral view of holotype, MCZ 9520, $\times$ 1. Figs. 3, 4, side and ventral view of paratype, MCZ 9521, $\times$ 1.	487
5, 6 <i>Keyserlingites bearlakensis</i> n. sp. Side and ventral view of paratype, MCZ 9518, $\times$ 3.	486
7, 8 <i>Stacheites</i> sp. indet. I Side and ventral view, MCZ 9487, $\times$ 1.	456
9, 10 <i>Stacheites</i> sp. indet. II Side and ventral view, MCZ 9501, $\times$ 1. Specimens of Figures 1-8 came from the upper member of Thaynes Formation, Hammond Creek, Bear River Range, southeastern Idaho; specimens of Figures 9, 10 came from the upper part of Thaynes Formation, Sublette Ridge, Wyoming.	457



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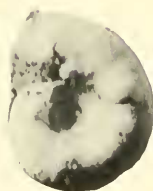
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PLATE 38. KEYSERLINGITES and PROHUNGARITES

Figures	Page
1-3 <i>Keyserlingites bearlakensis</i> n. sp. Figs. 1, 2, side and ventral view of holotype, MCZ 9516, $\times$ 1. Fig. 3, side view of paratype, MCZ 9517, $\times$ 1.	486
4, 5 <i>Prohungarites</i> sp. indet. Side and ventral view, MCZ 9647, $\times$ 1. All specimens are from the upper Thaynes Formation, Hammond Creek, Bear River Range, southeast Idaho.	522



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PLATE 39. COLUMBITES PARISIANUS

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1-10 *Columbites parisianus* Hyatt and Smith

Figs. 1, 2, front and side view of paratype, Hyatt and Smith (1905: pl. 61, figs. 2, 3), USNM 75286b, $\times 1$.
Figs. 3, 4, front and side view of holotype, Hyatt and Smith (1905: pl. 1, figs. 9, 10), USNM 75246a, $\times 1$.
Figs. 5-7, front, ventral, and side views of paratype, Hyatt and Smith (1905: pl. 61, figs. 5-7), USNM 75286c, $\times 1$. Figs. 8, 9, front and side view of paratype, Hyatt and Smith (1905: pl. 1, figs. 12-14), USNM 75246b, $\times 1$. Fig. 10, front view of paratype, Hyatt and Smith (1905: pl. 61, fig. 10), USNM 75286e, $\times 1$.
All specimens are from the middle shale member of Thaynes Formation (*Columbites* fauna), Paris Canyon, Bear River Range, southeast Idaho.

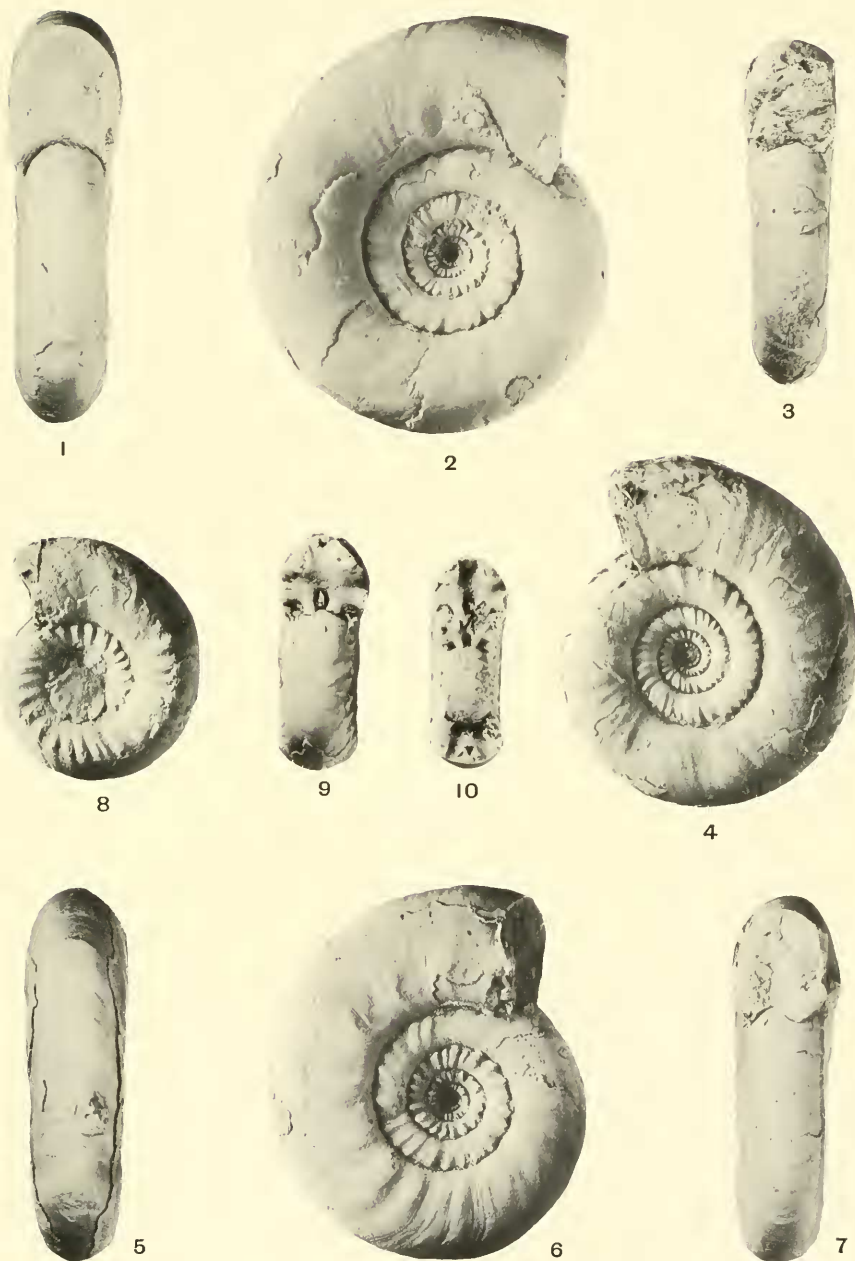


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PLATE 40. COLUMBITES PARISIANUS

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1-11 <i>Columbites parisianus</i> Hyatt and Smith Figs. 1, 2, front and side view of holotype of <i>Columbites ornatus</i> Smith (1932: pl. 46, figs. 14, 15), USNM 74984a, $\times$ 1. Figs. 3, 4, front and side view of paratype of <i>Columbites spencei</i> Smith (1932: pl. 78, figs. 13-15), USNM 75309g, $\times$ 2. Figs. 5, 6, front and side view of paratype of <i>Columbites spencei</i> Smith (1932: pl. 78, figs. 11, 12), USNM 75309f, $\times$ 2. Figs. 7-9, side, ventral, and front view of paratype of <i>Columbites ligatus</i> Smith (1932: pl. 47, figs. 6-8), USNM 74985c, $\times$ 1. Figs. 10, 11, side and ventral view of paratype of <i>Columbites ornatus</i> Smith (1932: pl. 46, figs. 16, 17), USNM 74984b, $\times$ 1. All specimens are from the middle shale member of Thaynes Formation (<i>Columbites</i> fauna), Paris Canyon, Bear River Range, southeast Idaho.	424



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PLATE 41. COLUMBITES PARISIANUS

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1-7 <i>Columbites parisianus</i> Hyatt and Smith	424
Figs. 1, 2, front and side view of holotype of <i>Columbites consanguineus</i> Smith (1932: pl. 46, figs. 1, 2), USNM 74983a, $\times$ 1. Figs. 3, 4, ventral and side view of paratype of <i>Columbites consanguineus</i> Smith (1932: pl. 46, figs. 3, 4), USNM 74983b, $\times$ 1. Figs. 5, 6, front and side view of paratype of <i>Columbites consanguineus</i> Smith (1932: pl. 46, figs. 5, 6), USNM 74983c, $\times$ 1. Fig. 7, side view of paratype of <i>Columbites parisianus</i> Hyatt and Smith (1904: pl. 61, fig. 1), USNM 75286a, $\times$ 1.	
All specimens are from the middle shale member of Thaynes Formation (<i>Columbites</i> fauna) Paris Canyon, Bear River Range, southeast Idaho.	



Plate 41

PLATE 42. COLUMBITES PARISIANUS

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1-9 *Calumbites parisianus* Hyatt and SmithPage
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Figs. 1, 2, front and side view of holotype of *Calumbites spencei* Smith (1932: pl. 78, figs. 1, 2), USNM 75309a, $\times 1$. Figs. 3, 4, front and side view of paratype of *Calumbites spencei* Smith (1932: pl. 78, figs. 5, 6), USNM 75309c, $\times 1$. Figs. 5, 6, front and side view of paratype of *Calumbites spencei* Smith (1932: pl. 78, figs. 9, 10), USNM 75309e, $\times 2$. Fig. 7, side view of paratype of *Calumbites ligatus* Smith (1932: pl. 47, fig. 4), USNM 74985b, $\times 1$. Figs. 8, 9, front and side view of paratype of *Calumbites spencei* Smith (1932: pl. 78, figs. 7, 8), USNM 75309d, $\times 1$.

All specimens are from the middle shale member of Thaynes Formation (*Calumbites* fauna), Paris Canyon, Bear River Range, southeast Idaho.

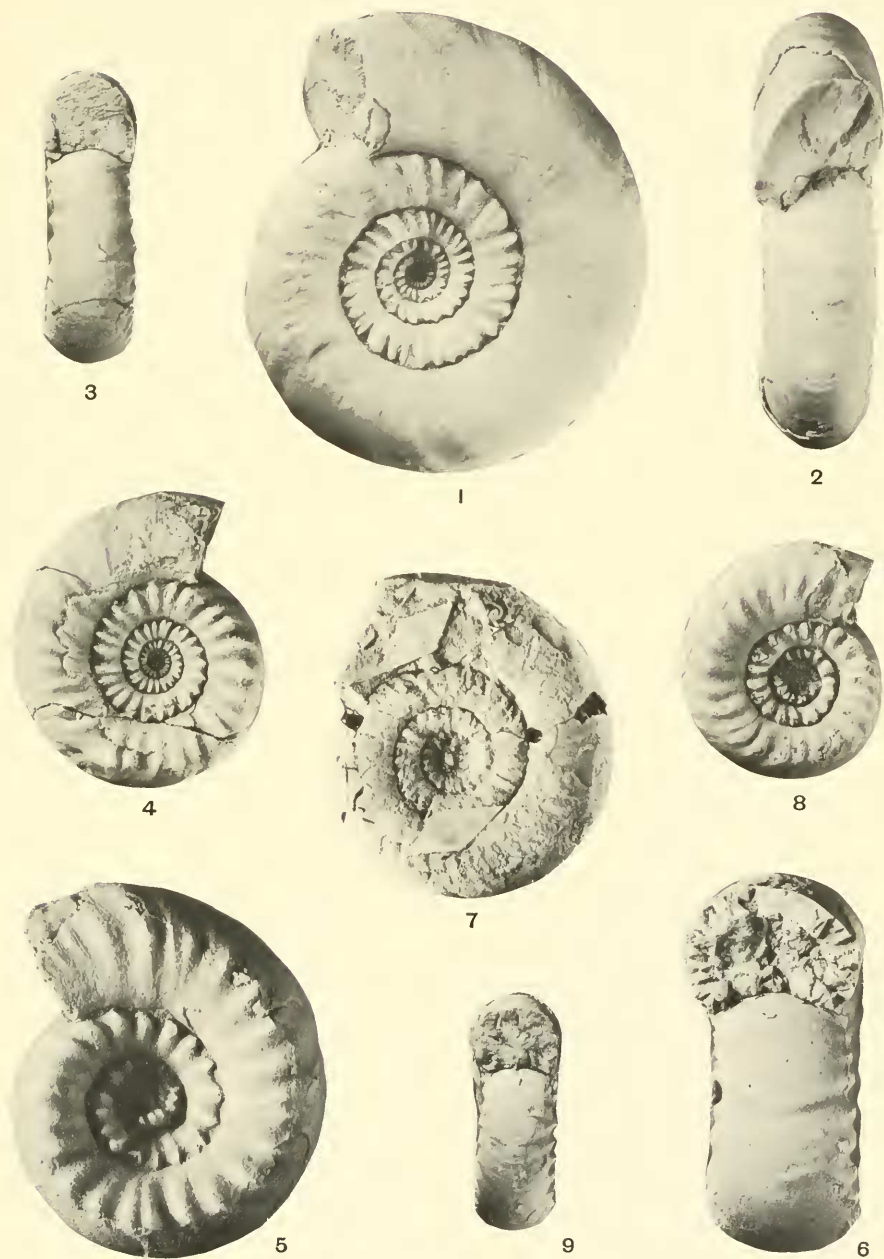


Plate 42

PLATE 43. SVALBARDICERAS, PREFLORIANITES, and COLUMBITES

Figures	Page
1 <i>Svalbardiceras sheldoni</i> n. sp. Side view of holotype, MCZ 9493, $\times$ 1.	453
2, 3 <i>Preflorianites montpelierensis</i> n. sp. Side and ventral view of paratype, MCZ 9495, $\times$ 1.5.	382
4, 5 <i>Columbites parisianus</i> Hyatt and Smith Side and front view of holotype of <i>Columbites ligatus</i> Smith (1932: pl. 47, figs. 1-3), USNM 74985a, $\times$ 1. All specimens are from the middle shale member of Thaynes Formation (<i>Columbites</i> fauna), southeast Idaho. Specimen of Figure 1 from Sage Creek, of Figures 2, 3 from Montpelier Canyon, and of Figures 4, 5 from Paris Canyon.	425

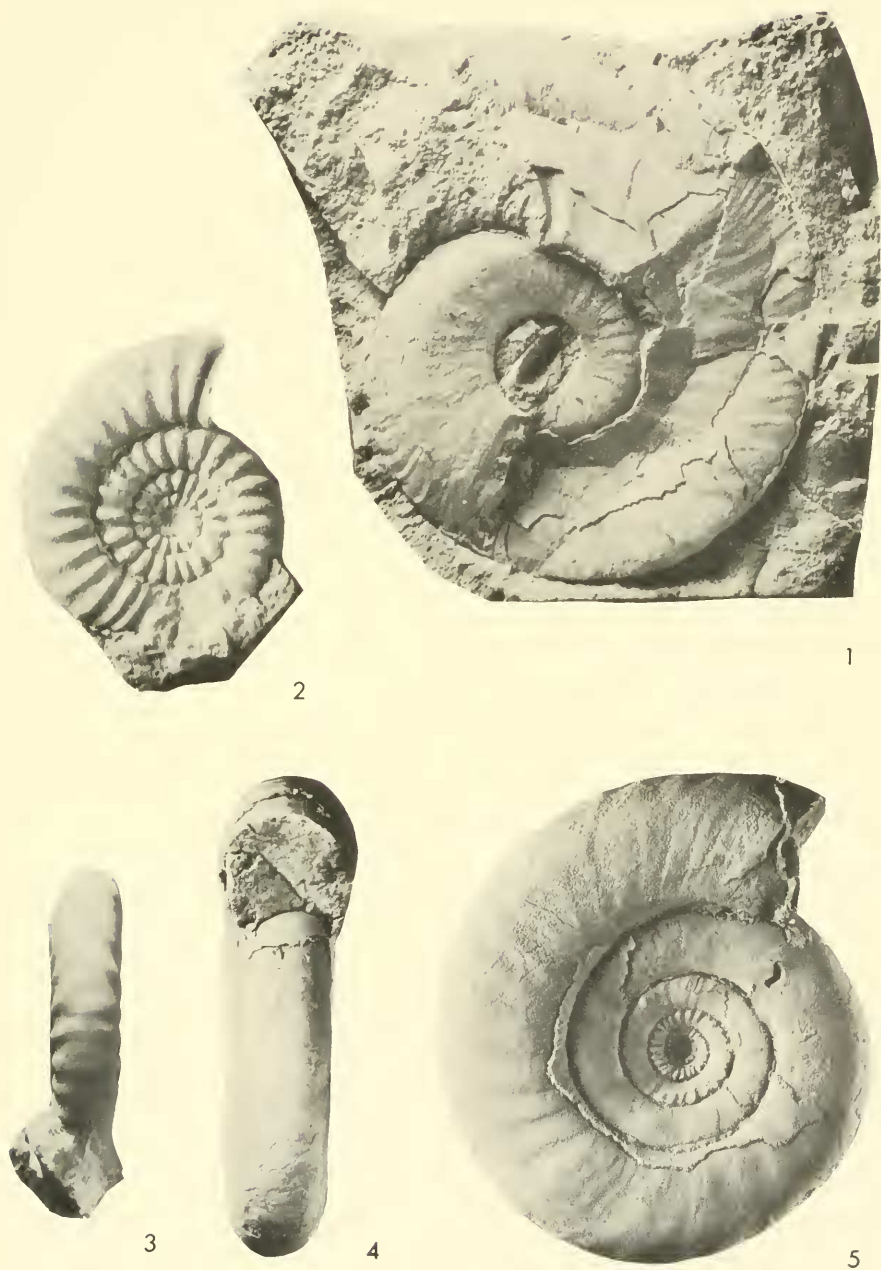


Plate 43

PLATE 44. USSURITES, PSEUDOCELITES, PREFLORIANITES, and PSEUDASPIDITES

Figures		Page
1-3	<i>Ussurites mansfieldi</i> n. sp. Fig. 1, side view of paratype, MCZ 9515, $\times$ 1. Figs. 2, 3, ventral and side view of paratype, MCZ 9513, $\times$ 1.	530
4-10	<i>Pseudoceltites cheneyi</i> n. sp. Fig. 4, paratype, MCZ 9503, $\times$ 1. Fig. 5, paratype, MCZ 9504, $\times$ 1. Figs. 6, 7, paratype, MCZ 9505, $\times$ 1. Figs. 8, 9, holotype, USNM 153073, $\times$ 1. Fig. 10, paratype, MCZ 9506, $\times$ 1.	438
11-13	<i>Preflorianites montpelierensis</i> n. sp. Fig. 11, paratype, MCZ 9635, $\times$ 1. Fig. 12, paratype, MCZ 9498, $\times$ 1. Fig. 13, holotype, MCZ 9494, $\times$ 1.	382
14-15	<i>Pseudaspidites popovi</i> n. sp. Side and ventral view of juvenile specimen, MCZ 9636, $\times$ 1.	383

All specimens come from the middle shale member of Thaynes Formation (Columbites fauna), southeast Idaho. Specimens of Figures 8, 9, from Draney Creek, of Figure 13 from Montpelier Canyon, all others from Hot Springs.

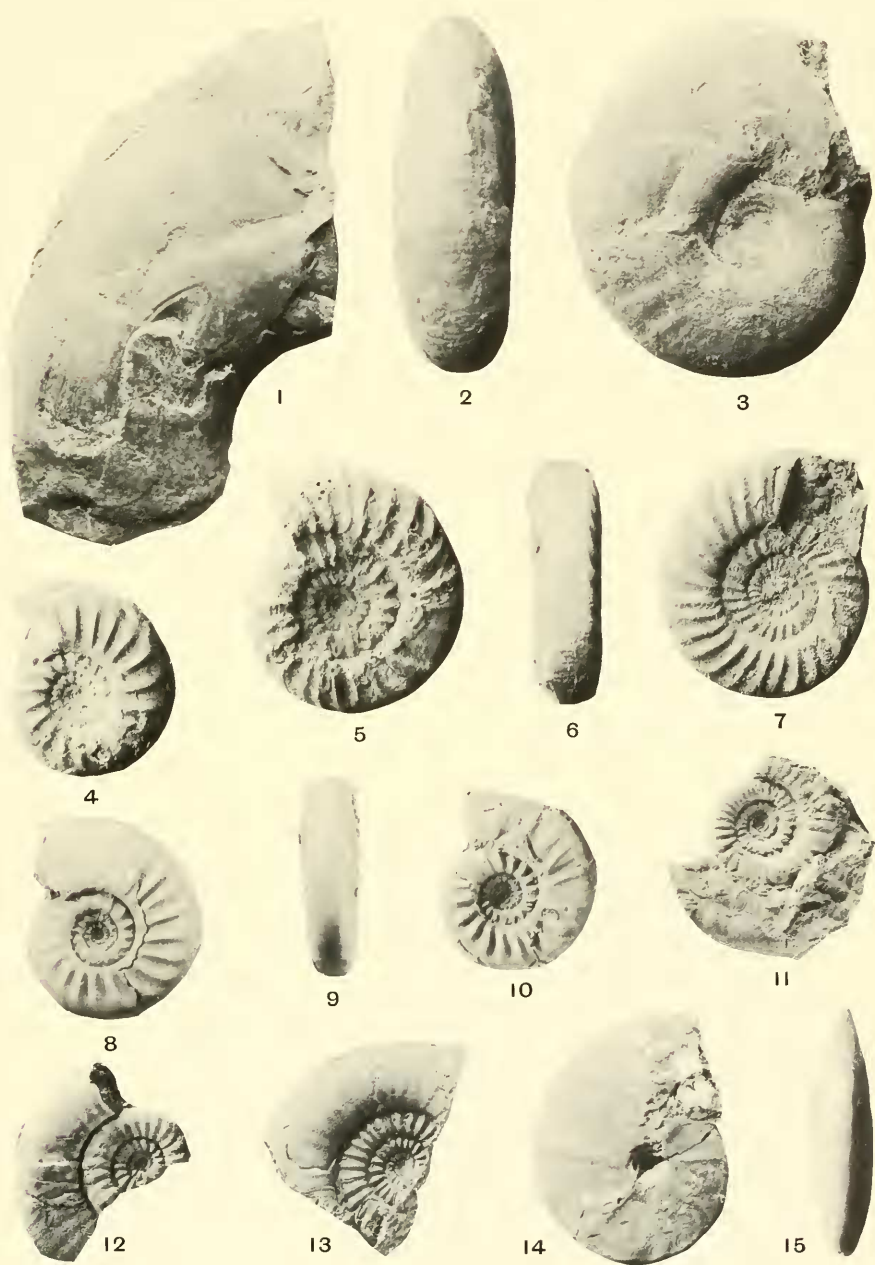


Plate 44

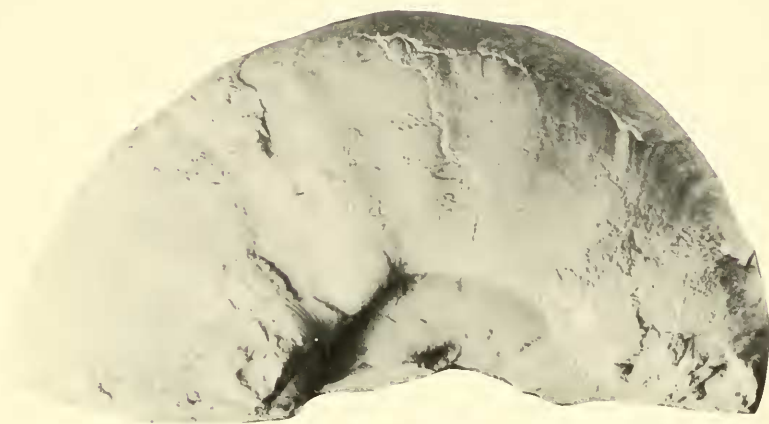
PLATE 45. USSURITES MANSFIELDI

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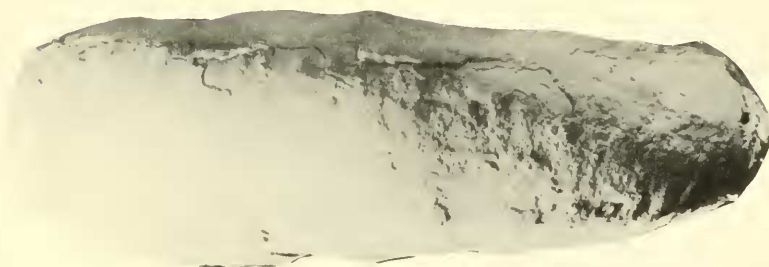
Figures
1-3 *Ussurites mansfieldi* n. sp.

Fig. 1, holotype, $\times 0.5$. Figs. 2, 3, paratype, $\times 0.8$.

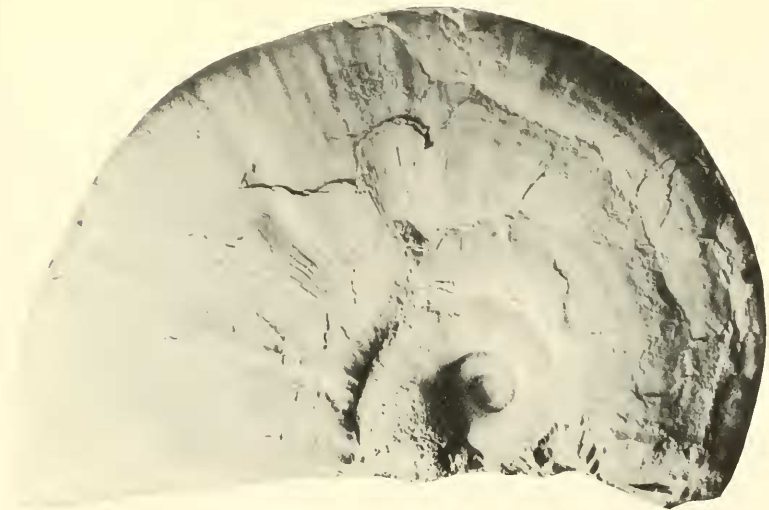
Both specimens are from the middle shale member of Thaynes Formation (Columbites fauna) in Webster Canyon, southeast Idaho, and are deposited in the Department of Geology, Washington State University.



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Plate 45

PLATE 46. KEYSERLINGITES and NORDOPHICERAS

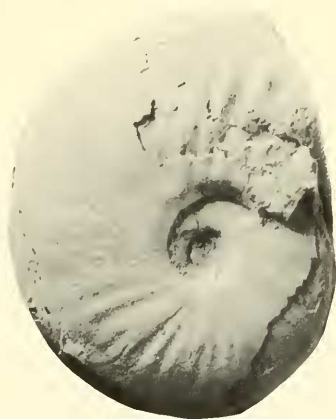
Figures	Page
1 <i>Keyserlingites stephensoni</i> n. sp. Side view of the holotype deposited in Department of Geology, Washington State University. Specimen is presumably from the <i>Calumbites</i> fauna, Fort Hall Indian Reservation, southeast Idaho, $\times 0.3$.	487
2, 3 <i>Nordaphiceras pilatum</i> (Hyatt and Smith) Fig. 2, MCZ 9543, $\times 1.5$. Fig. 3, MCZ 9544, $\times 1.5$. Both specimens are from the middle shale member of Thaynes Formation (<i>Calumbites</i> fauna) southeast Idaho, Figure 2, from Montpelier Canyon, Figure 3, from Hat Springs.	470



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PLATE 47. NORDOPHICERAS

- | Figures | Page |
|--|------|
| 1-5 <i>Nardaphiceras jacksoni</i> (Hyatt and Smith) | 468 |
| Fig. 1, MCZ 9564, $\times$ 1. Fig. 2, MCZ 9565, $\times$ 1. Fig. 3, MCZ 9566, $\times$ 3. Fig. 4, MCZ 9567, $\times$ 1.5.
Fig 5, MCZ 9568, $\times$ 1.5. | |
| All specimens are from the middle shale member of Thaynes Formation (<i>Calumbites</i> fauna), southeast Idaho. Specimen of Figure 1 is from Montpelier Canyon, Figure 2 is from Paris Canyon, and the others are from Hot Springs. | |
| 6-8 <i>Nardaphiceras euamphalus</i> (Keyserling) | 465 |
| Fig. 6, MCZ 9655, $\times$ 1. Figs. 7, 8, MCZ 8680, $\times$ 1.5.
Tapotype specimens are from the Olenekian fauna, Olenek River, Siberia. | |



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PLATE 48. *NORDOPHICERAS* and *XENOCELTITES*

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1-4 <i>Nardophiceras jacksoni</i> (Hyatt and Smith)	468
Figs. 1, 2, side and front view of paratype (Hyatt and Smith, 1905: pl. 62, figs. 15, 16), USNM 75292c, $\times$ 1.	
Figs. 3, 4, side and front view of holotype (Hyatt and Smith, 1905: pl. 62, figs. 11-13), USNM 75292a, $\times$ 1.	
5-9 <i>Xenoceltites spencei</i> (Hyatt and Smith)	376
Figs. 5, 6, side and front view of paralectotype (Hyatt and Smith, 1905: pl. 62, figs. 5-7), USNM 75291b, $\times$ 1.	
Figs. 7-9, side, front, and ventral view of lectotype (Hyatt and Smith, 1905: pl. 62, figs. 1-3), USNM 75291a, $\times$ 1.	
All specimens are from the middle shale member of Thaynes Formation (<i>Calumbites</i> fauna), Paris Canyon, Bear River Range, southeast Idaho.	



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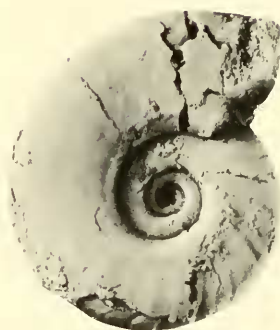
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PLATE 49. NORDOPHICERAS PILATUM

Figures	Page
1-8 <i>Nardophipiceras pilatum</i> (Hyatt and Smith)	470
Fig. 1, side view of paratype of <i>Meekoceras sanctorum</i> Smith (1932: pl. 49, fig. 3), USNM 74991b, $\times$ 1. Figs. 2, 3, side and front view of holotype of <i>Meekoceras sanctorum</i> Smith (1932: pl. 49, figs. 1, 2), USNM 74991a, $\times$ 1. Figs. 4-6, side, front, and ventral view of paralectotype of <i>Meekoceras pilatum</i> Hyatt and Smith (1905: pl. 63, figs. 10-12), USNM 75294b, $\times$ 1. Figs. 7, 8, side and ventral view of lectotype of <i>Meekoceras pilatum</i> Hyatt and Smith (1905: pl. 63, figs. 7, 8), USNM 75294a, $\times$ 1. All specimens are from the middle shale member of Thaynes Formation (<i>Columbites</i> fauna), Paris Canyon, Bear River Range, southeast Idaho.	



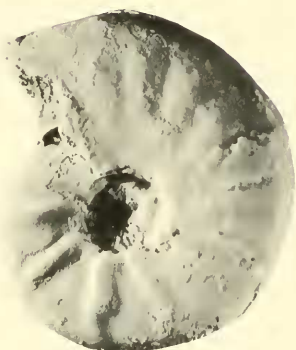
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PLATE 50. NORDOPHICERAS PILATUM

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1-11 *Nordophriceras pilatum* (Hyatt and Smith)

Figs. 1, 2, side and front view of holotype of *Meekoceras curticostratum* Smith (1932: pl. 48, figs. 21-22), USNM 74990a, $\times$ 1. Fig. 3, side view of paratype of *Meekoceras curticostratum* Smith (1932: pl. 48, figs. 27, 28), USNM 74990d, $\times$ 1. Fig. 4, side view of paratype of *Meekoceras curticostratum* Smith (1932: pl. 48, figs. 29, 30), USNM 74990e, $\times$ 2. Fig. 5, side view of paratype of *Meekoceras curticostratum* Smith (1932: pl. 48, figs. 25, 26), USNM 74990c, $\times$ 1. Fig. 6, side view of paratype of *Meekoceras curticostratum* Smith (1932: pl. 48, figs. 23, 24), USNM 74990b, $\times$ 1. Figs. 7-9, side, front, and ventral view of holotype of *Meekoceras micromphalus* Smith (1932: pl. 49, figs. 5-7), USNM 74992a, $\times$ 1. Figs. 10, 11, side and front view of paratype of *Meekoceras micromphalus* Smith (1932: pl. 49, figs. 9-11), USNM 74992b, $\times$ 2.

All specimens are from the middle shale member of Thaynes Formation (Columbites fauna), Paris Canyon, Bear River Range, southeast Idaho.

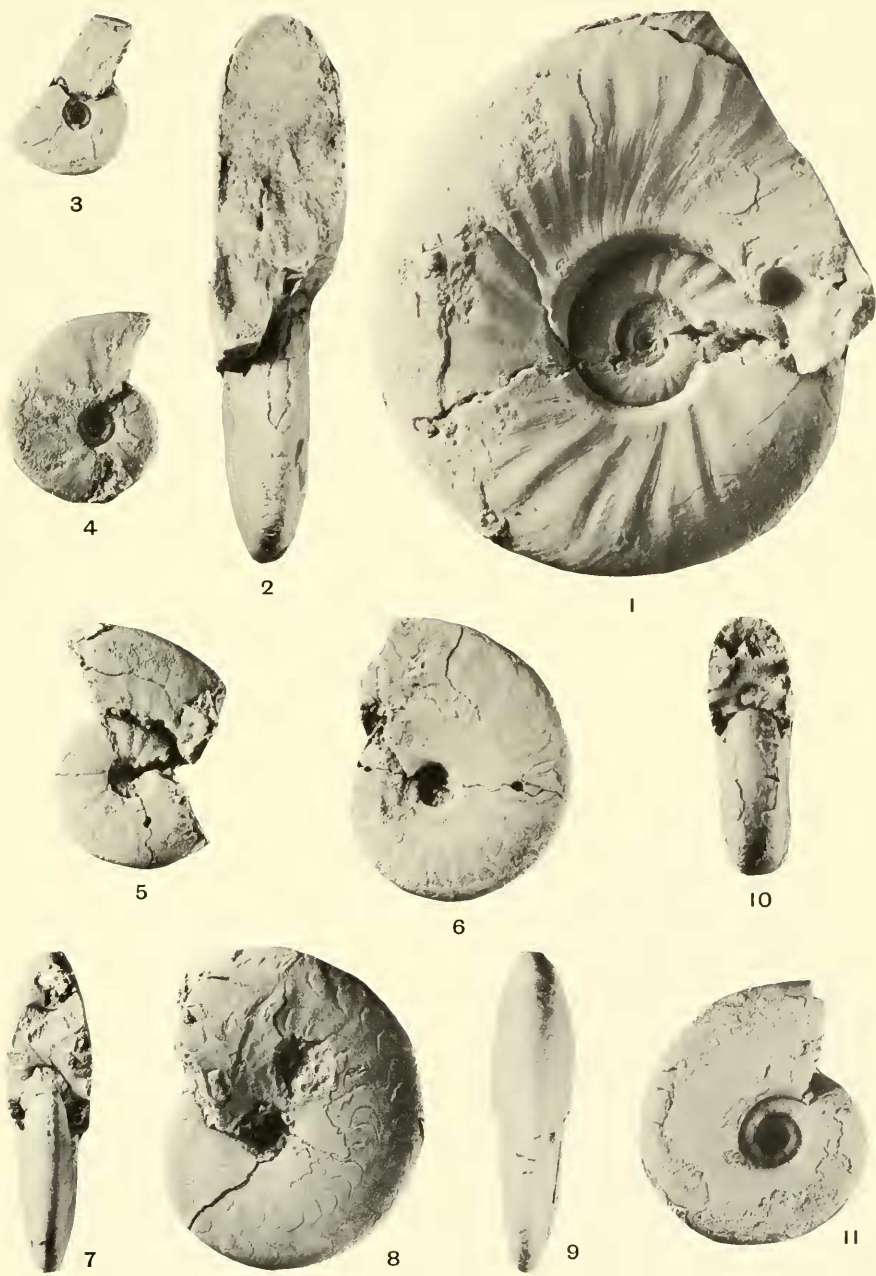


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PLATE 51. NORDOPHICERAS and CORDILLERITES

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1-5 <i>Nardophipiceras pilatum</i> (Hyatt and Smith)	470
Fig. 1, MCZ 9539, $\times$ 1. Figs. 2, 3, MCZ 9542, $\times$ 1. Fig. 4, MCZ 9540, $\times$ 1. Fig. 5, MCZ 9541, $\times$ 1.	
6, 7 <i>Cardillerites angulatus</i> Hyatt and Smith	364
Side and ventral view, MCZ 9569, $\times$ 1.	
All specimens are from the middle shale member of Thaynes Formation (<i>Columbites</i> fauna), Montpelier Canyon, southeast Idaho.	



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PLATE 52. XENOCELTITES SPENCEI

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1-7 <i>Xenoceltites spencei</i> (Hyatt and Smith)	376
Fig. 1, MCZ 9551, $\times$ 1. Fig. 2, MCZ 9552, $\times$ 2. Fig. 3, MCZ 9553, $\times$ 1.5. Fig. 4, MCZ 9554, $\times$ 1.5. Fig. 5, MCZ 9555, $\times$ 2. Fig. 6, MCZ 9556, $\times$ 1.5. Fig. 7, MCZ 9557, $\times$ 3.	
All specimens are from the middle shale member of Thoynes Formation (<i>Columbites</i> fauna), southeast Idaho. Specimens of Figures 1, 4, 6, and 7 are from Montpelier Canyon; specimens of Figures 2, 3, and 5 are from Hot Springs.	



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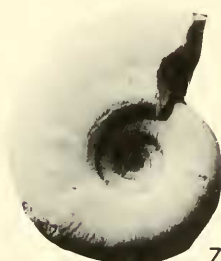
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PLATE 53. DIENEROCERAS, HELLENITES, and SUBVISHNUITES

Figures		Page
1-12	<i>Dieneroceras apostolicus</i> (Smith)	369
	Figs. 1, 2, side and front view of holotype of <i>Celtites ursensis</i> Smith (1932: pl. 47, figs. 11, 12), USNM 74987a, $\times 1$. Figs. 3, 4, side and ventral view of paratype of <i>Celtites ursensis</i> Smith (1932: pl. 47, figs. 13, 14), USNM 74987b, $\times 1$. Figs. 5, 6, side and front view of paratype of <i>Celtites ursensis</i> Smith (1932: pl. 47, figs. 15, 16), USNM 74987c, $\times 1$. Figs. 7, 8, side and front view of holotype of <i>Celtites planovalvis</i> Smith (1932: pl. 48, figs. 11, 12), USNM 74988a, $\times 1$. Fig. 9, side view of paratype of <i>Celtites planovalvis</i> Smith (1932: pl. 48, figs. 13, 14), USNM 74988b, $\times 1$. Figs. 10, 11, side and front view of holotype of <i>Celtites apostolicus</i> Smith (1932: pl. 48, figs. 1, 2), USNM 74989a, $\times 1$. Fig. 12, side view of paratype of <i>Celtites apostolicus</i> Smith (1932: pl. 48, figs. 3, 4), USNM 74989b, $\times 1$.	
13, 14	<i>Hellenites idahoense</i> (Smith)	516
	Side and ventral view of holotype (Smith, 1932: pl. 49, figs. 17, 18), USNM 74994, $\times 2$.	
15	<i>Subvishnuites</i> sp. indet.	374
	Side view, MCZ 9512, $\times 1$.	
	All specimens are from the middle shale member of Thaynes Formation (<i>Columbites</i> fauna), Idaho. The specimens of Figures 1-14 are from Paris Canyon, and the specimen of Figure 15 is from Montpellier Canyon.	

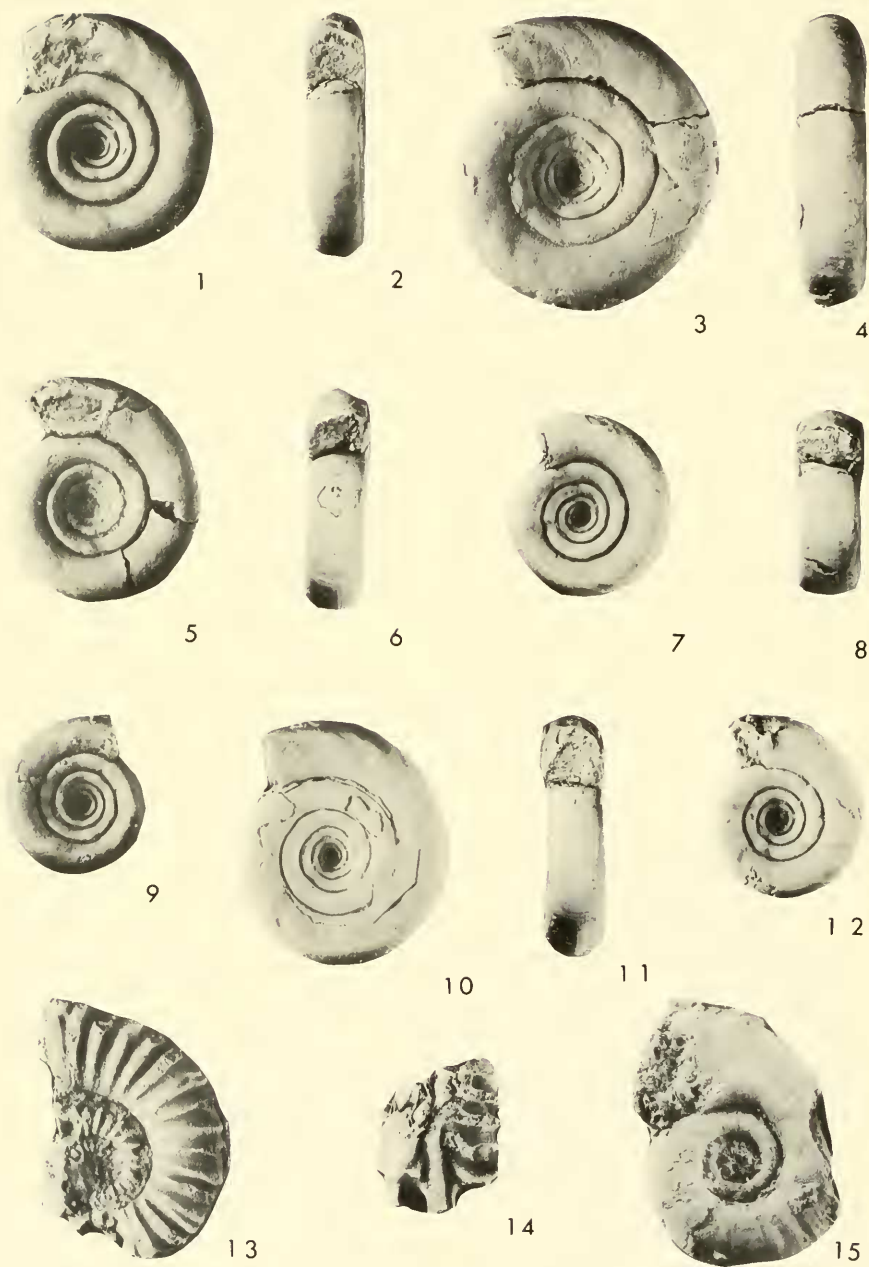


Plate 53

PLATE 54. TIROLITES SMITHI

Figures

Page

1-5 *Tirolites smithi* n. sp.

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Fig. 1, specimen from Montpelier Canyon, MCZ 9547, $\times$ 1. Figs. 2, 3, ventral and side view of *Tirolites illyricus* Mojsisovics from Paris Canyon, figured by Smith (1932: pl. 49, figs. 12, 13), USNM 74993, $\times$ 1. Figs. 4, 5, side and ventral view of juvenile form from Montpelier Canyon, MCZ 9548, $\times$ 1.

All specimens are from the middle shale member of Thaynes Formation (*Columbites* fauna), southeast Idaho.



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PLATE 55. TIROLITES, DALMATITES, and PSEUDASPIDITES

Figures	Page
1-3 <i>Tirolites ostokhovi</i> n. sp. Figs. 1, 2, side and ventral view of holotype, USNM 153081, $\times$ 1. Fig. 3, side view of paratype, USNM 153082, $\times$ 1.	502
4, 5 <i>Tirolites</i> sp. indet. II Side and ventral view, MCZ 9502, $\times$ 1.	503
6, 7 <i>Dalmatites kittli</i> n. sp. Side and ventral view of holotype, MCZ 9499, $\times$ 1.5.	522
8, 9 <i>Pseudaspidites popovi</i> n. sp. Side and ventral view of holotype, MCZ 9575, $\times$ 1. All specimens are from the middle shale member of Thaynes Formation (<i>Columbites</i> fauna), Idaho. Specimens of Figures 1-3, from Sage Creek, of Figures 4, 5, from Montpelier Canyon, of Figures 6, 7, from Paris Canyon, of Figures 8, 9, from Hot Springs.	383

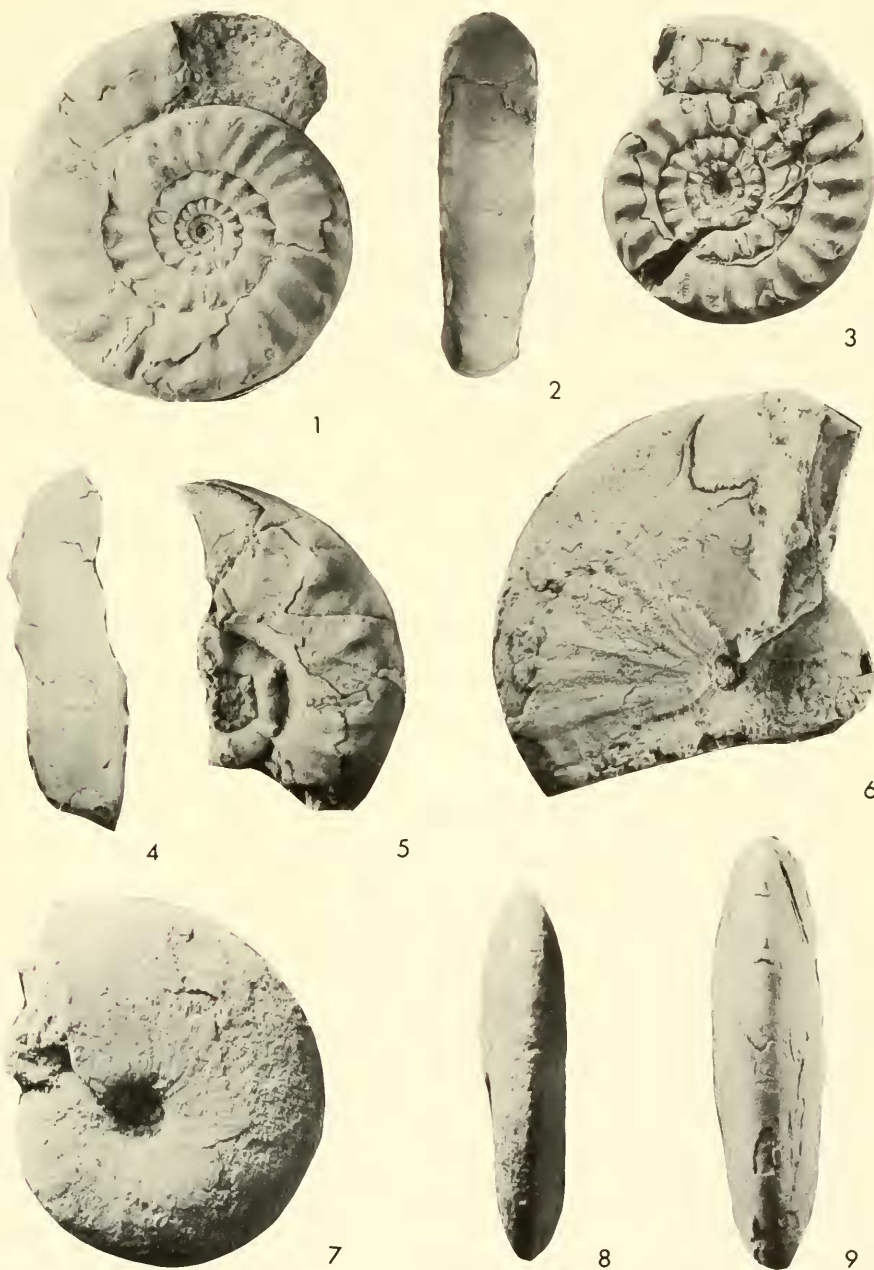


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PLATE 56. DALMATITES and STACHEITES

Figures		Page
1-8	<i>Dalmatites morlaccus</i> Kittl Figs. 1, 2, lectotype, Kittl (1903: pl. 4, fig. 4), $\times$ 1. Figs. 3, 4, paralectotype, Kittl (1903: fig. 5), $\times$ 1. Figs. 5, 6, paralectotype, Kittl (1903: fig. 6), $\times$ 1. Figs. 7, 8, paralectotype, Kittl (1903: fig. 7), $\times$ 1.	522
9, 10	<i>Stacheites prionoides</i> Kittl Holotype, Kittl (1903: pl. 4, fig. 8), $\times$ 1. All specimens are from the Werfen Formation at Muć, Dalmatia, and are deposited in the Natural History Museum, Vienna.	455

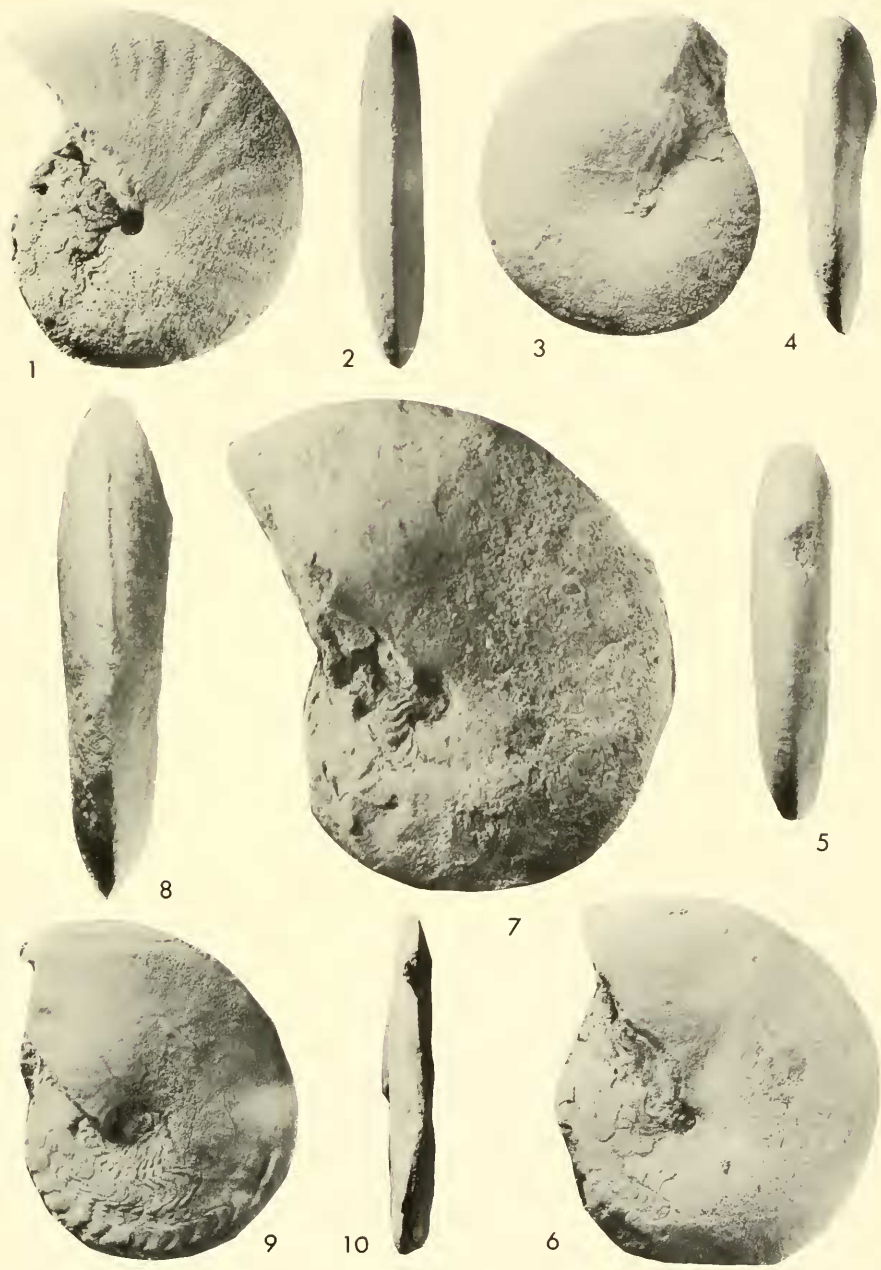


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PLATE 57. BITTNERITES and PSEUDODINARITES

Figures	Page
1-6 <i>Bittnerites bittneri</i> Kittl	504
Figs. 1, 2, lectotype, Kittl (1903: pl. 11, fig. 10), $\times$ 1. Figs. 3, 4, holotype, <i>Bittnerites malici</i> Kittl (1903: pl. 3, fig. 8), $\times$ 1. Figs. 5, 6, holotype, <i>Bittnerites telleri</i> Kittl (1903: pl. 10, fig. 10), $\times$ 1.	
7-9 <i>Pseudodinarites mohamedanus</i> (Mojsisovics)	511
Figs. 7, 8, plesiotype,-Kittl (1903: pl. 3, fig. 7), $\times$ 1; Fig. 9, plesiotype,-Kittl (1903: pl. 3, fig. 6), $\times$ 1.	
All specimens are from the Werfen Formation at Muć, Dalmatia, and are deposited in the Natural History Institute, Vienna.	



Plate 57

PLATE 58. DINARITES DALMATINUS

Figures

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1-10 *Dinarites dalmatinus* (Hauer)

Fig. 1, plesiotype, *Dinarites nudus* Tommasi,-Kittl (1903: pl. 1, fig. 13), $\times$ 1. Fig. 2, plesiotype, *Dinarites laevis* Tommasi,-Kittl (1903: pl. 3, fig. 11), $\times$ 1. Figs. 3, 4, plesiotype, *Dinarites laevis* Tommasi,-Kittl (1903: pl. 3, fig. 10), $\times$ 1. Figs. 5, 6, plesiotype, *Dinarites dalmatinus* (Hauer),-Kittl (1903: pl. 2, fig. 1), $\times$ 1. Fig. 7, plesiotype, *Dinarites dalmatinus* (Hauer),-Kittl (1903: pl. 2, fig. 5), $\times$ 1. Fig. 8, plesiotype, *Dinarites dalmatinus* (Hauer),-Kittl (1903: pl. 2, fig. 6), $\times$ 1. Figs. 9, 10, plesiotype, *Dinarites dalmatinus* (Hauer),-Kittl (1903: pl. 2, fig. 3), $\times$ 1.

All specimens are from the Werfen Formation at Muć, Dalmatia, and are deposited in the Natural History Museum, Vienna.

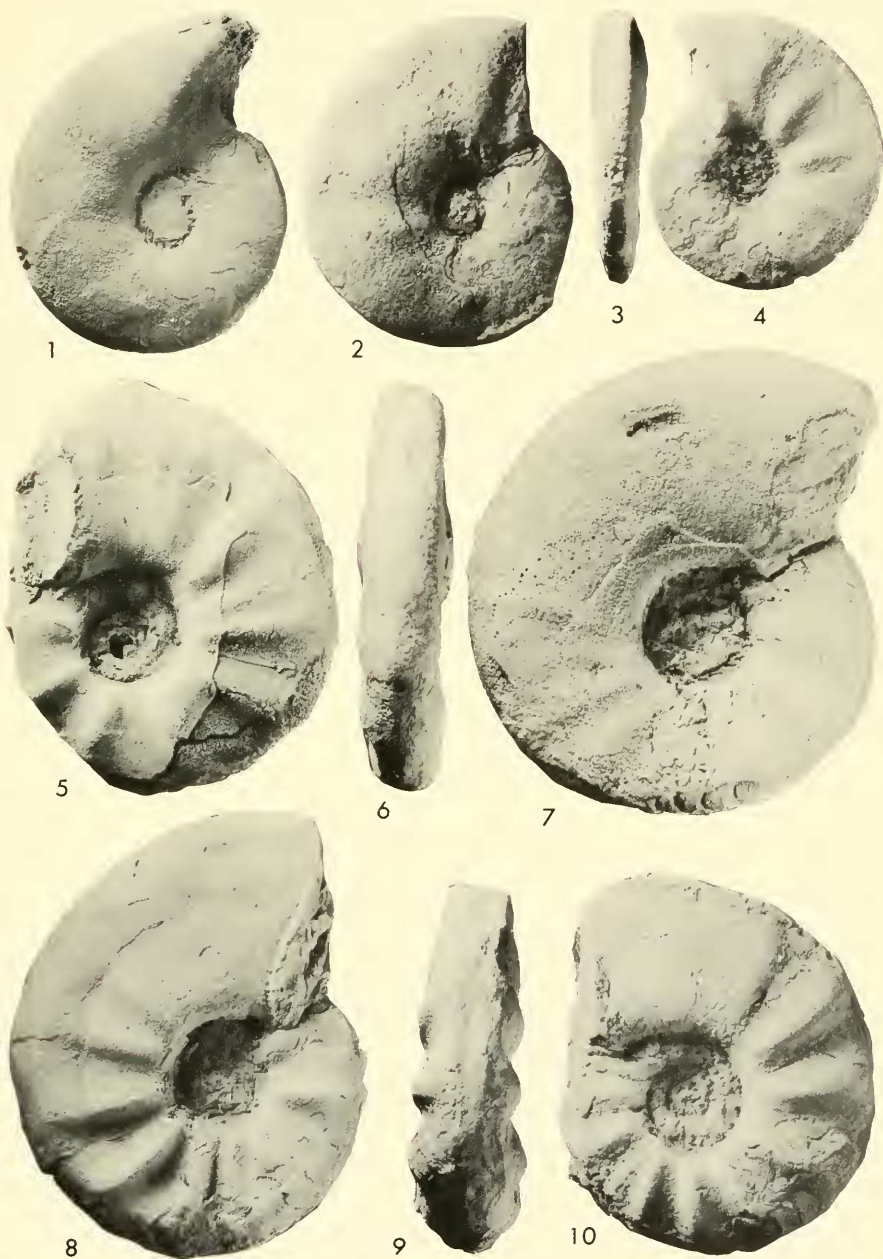


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PLATE 59. DINARITES DALMATINUS

Figures

1-11 *Dinarites dalmatinus* (Hauer)

Figs. 1, 2, plesiotype, *Dinarites laevis* Tommasi,-Kittl (1903: pl. 1, fig. 1), $\times$ 1. Figs. 3, 4, plesiotype, *Dinarites laevis* Tommasi,-Kittl (1903: pl. 1, figs. 2, 3), $\times$ 1. Figs. 5, 6, plesiotype, *Dinarites muchionus* (Hauer),-Kittl (1903: pl. 1, fig. 7), $\times$ 1. Figs. 7, 8, plesiotype, *Dinarites muchionus* (Hauer),-Kittl (1903: pl. 1, fig. 5), $\times$ 1. Figs. 9, 10, syntype, *Dinarites evolutior* Kittl (1903: pl. 1, fig. 10), $\times$ 1. Fig. 11, syntype, *Dinarites evolutior* Kittl (1903: pl. 1, fig. 9), $\times$ 1.

All specimens are from the Werfen Formation of Muć, Dalmatia, and are deposited in the Natural History Museum, Vienna.

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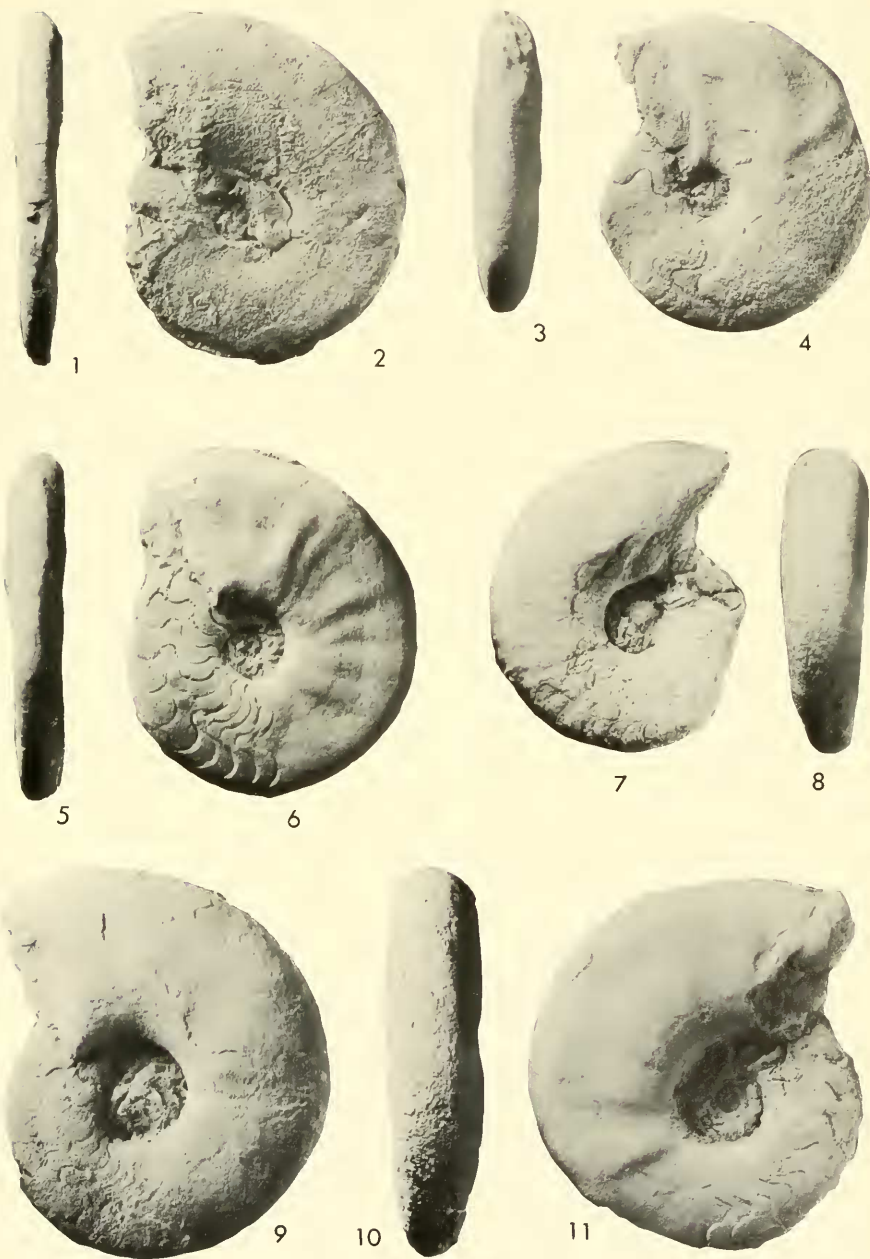


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PLATE 60. DINARITES DALMATINUS

Figures

1-8 *Dinarites dalmatinus* (Hoyer)

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Fig. 1, plesiotype, var. *plurimcostatus* Kittl (1903: pl. 2, fig. 10), $\times$ 1. Fig. 2, plesiotype, var. *externeplanatus* Kittl (1903: pl. 3, fig. 1), $\times$ 1. Fig. 3, plesiotype, var. *externeplanatus* Kittl (1903: pl. 3, fig. 2), $\times$ 1. Fig. 4, plesiotype, var. *extensus* (Kittl: 1903, pl. 2, fig. 8), $\times$ 1. Fig. 5, holotype *Dinarites multicostatus* Kittl (1903: pl. 3, fig. 3), $\times$ 1. Fig. 6, syntype, *Dinarites tiralitoides* Kittl (1903: pl. 7, fig. 3), $\times$ 1. Fig. 7, syntype, *Dinarites tiralitoides* Kittl (1903: pl. 7, fig. 2), $\times$ 1. Fig. 8, plesiotype, Kittl (1903: pl. 2, fig. 7), $\times$ 1.

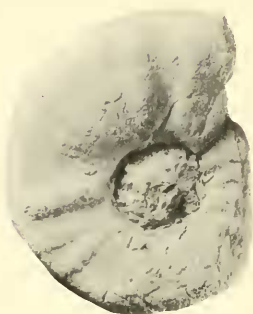
All specimens are from the Werfen Formation at Muć, Dalmatia, and are deposited in the Natural History Museum, Vienna.



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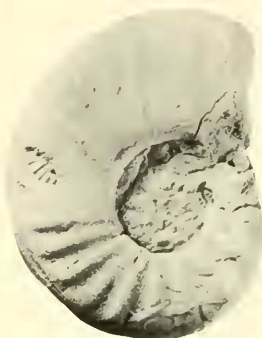
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PLATE 61. DINARITES CARNIOLICUS

Figures

Page

1-8 *Dinarites carniolicus* (Mojsisovics)

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Figs. 1, 2, plesiotype, Kittl (1903: pl. 5, fig. 1), $\times$ 1. Fig. 3, plesiotype, Kittl (1903: pl. 5, fig. 2), $\times$ 1. Fig. 4, plesiotype, Kittl (1903: pl. 5, fig. 3), $\times$ 1. Fig. 5, plesiotype, Kittl (1903: pl. 5, fig. 4), $\times$ 1. Figs. 6, 7, syntype, *Tirolites serratelobatus* Kittl (1903: pl. 5, fig. 4), $\times$ 1. Fig. 8, syntype, *Tirolites serratelobatus* Kittl (1903: pl. 5, fig. 6), $\times$ 1.

All specimens are from the Werfen Formation at Muć, Dalmatia, and are deposited in the Natural History Museum, Vienna.

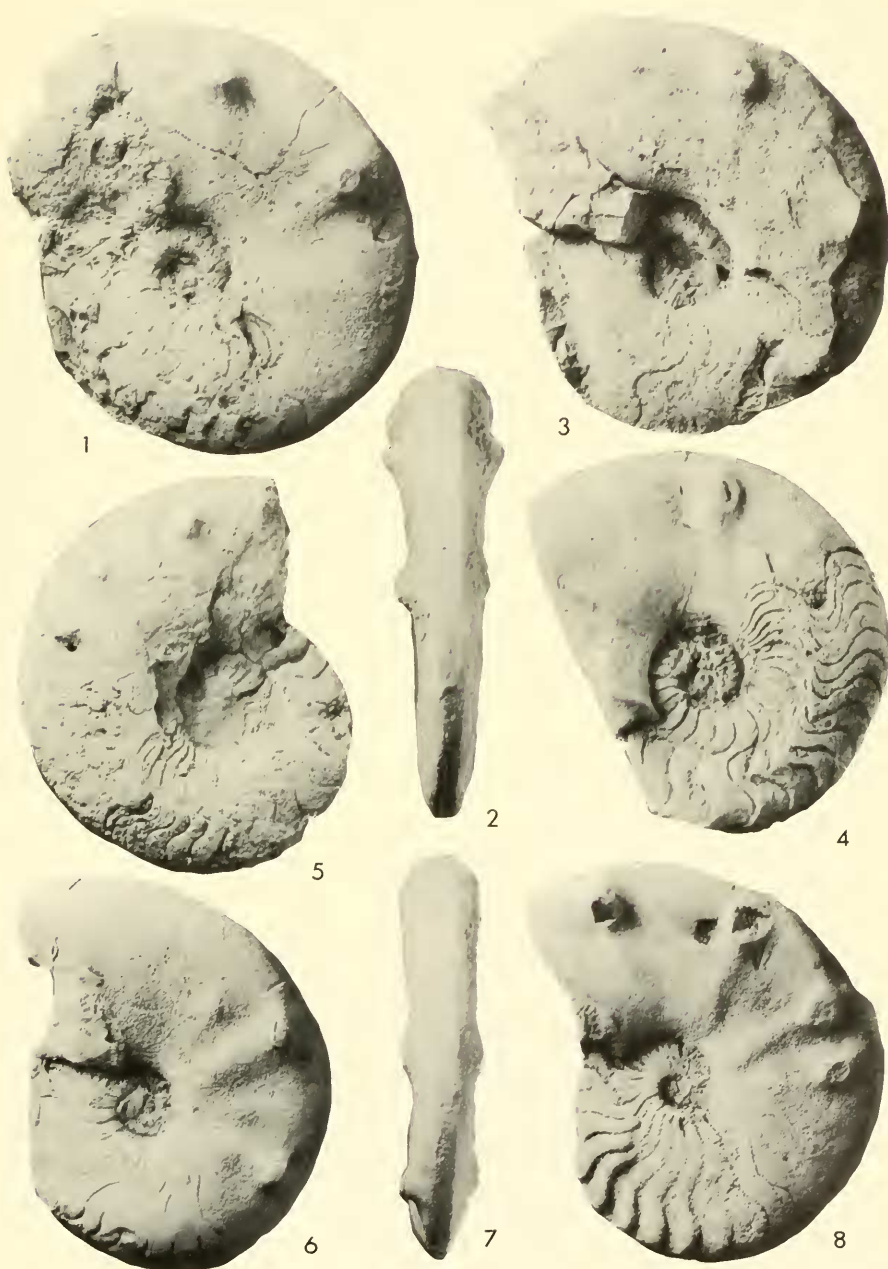


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PLATE 62. DIAPLOCOCERAS, PSEUDOKYMATITES, and PSEUDODINARITES

Figures	Page
1-4 <i>Diaplococeras connectens</i> (Mojsisovics)	504
Fig. 1, holotype, <i>Dinarites</i> (<i>Hercegovites</i>) <i>diocletiani</i> Kittl (1903: pl. 3, fig. 4), $\times$ 1. Fig. 2, lectotype, <i>Dinarites</i> (<i>Liccaites</i>) <i>progressus</i> Kittl (1903: pl. 4, fig. 2), $\times$ 1. Figs. 3, 4, lectotype, <i>Dinarites biangulatus</i> Kittl (1903: pl. 4, fig. 1), $\times$ 1.	
5 <i>Pseudokymatites svilajanus</i> (Kittl)	475
Holotype (Kittl, 1903: pl. 4, fig. 3), $\times$ 1.	
6 <i>Pseudodinarites mahamedanus</i> (Mojsisovics)	511
Plesiotype, -Kittl (1903: pl. 3, fig. 5), $\times$ 0.6.	
All specimens are from the Werfen Formation at Muć, Dalmatia, and are deposited in the Natural History Museum, Vienna.	

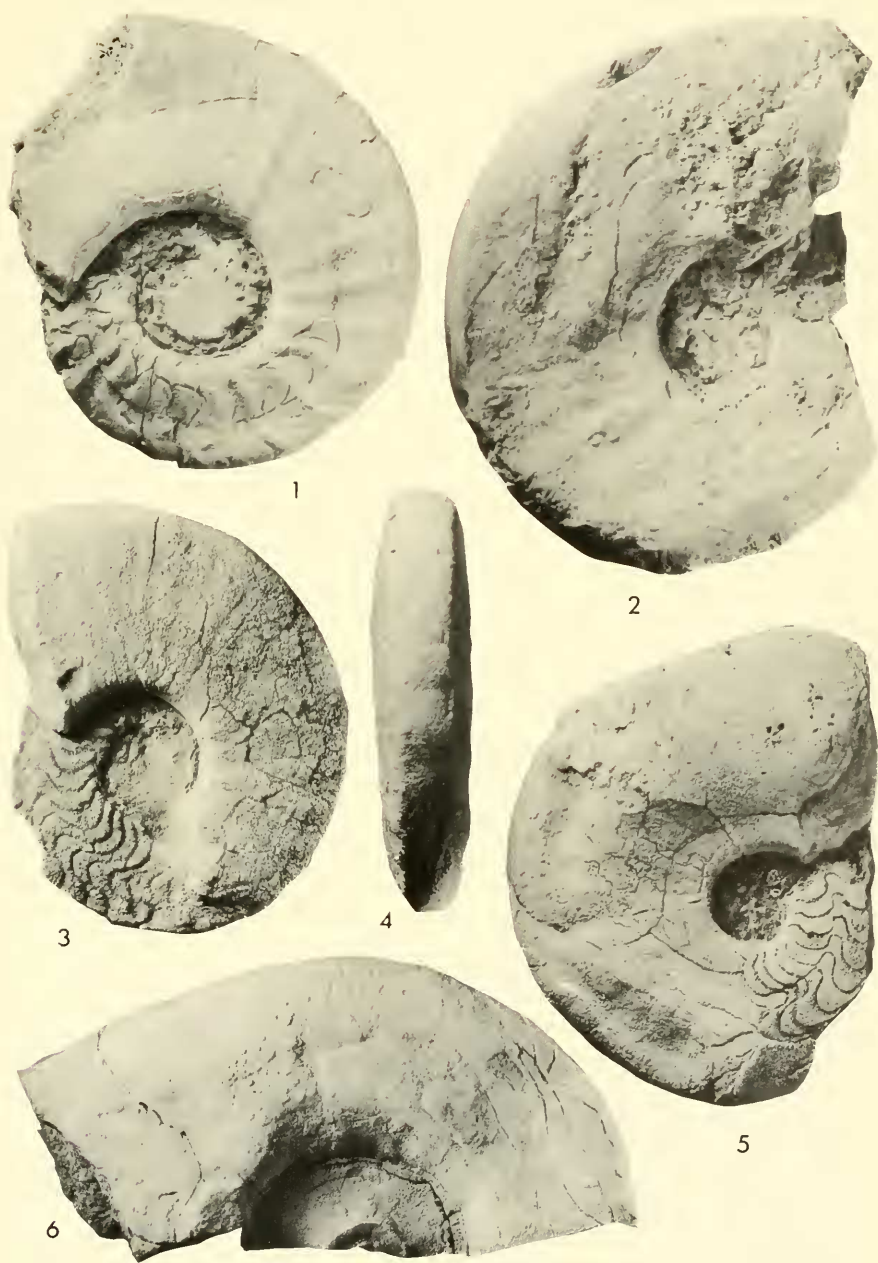


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PLATE 63. TIROLITES CASSIANUS

Figures

1-9 *Tirolites cassianus* (Quenstedt)Page
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Fig. 1, plesiotype, *Tirolites darwini*, -Kittl (1903: pl. 11, fig. 1), $\times 1$. Figs. 2, 3, plesiotype, *Tirolites darwini*, -Kittl (1903: pl. 10, fig. 5), $\times 1$. Fig. 4, lectotype, *Tirolites multispinatus* Kittl (1903: pl. 11, fig. 9), $\times 1$. Figs. 5, 6, lectotype, *Tirolites percastatus* Kittl (1903: pl. 10, fig. 6), $\times 1$. Fig. 7, plesiotype, *Tirolites turgidus*, -Kittl (1903: pl. 10, fig. 7), $\times 1$. Fig. 8, plesiotype, *Tirolites darwini*, -Kittl (1903: pl. 11, fig. 3), $\times 1$. Fig. 9, plesiotype, *Tirolites smiriagini*, -Kittl (1903: pl. 11, fig. 6), $\times 1$.

All specimens are from the Werfen Formation at Muć, Dalmatia, and are deposited in the Natural History Museum, Vienna.

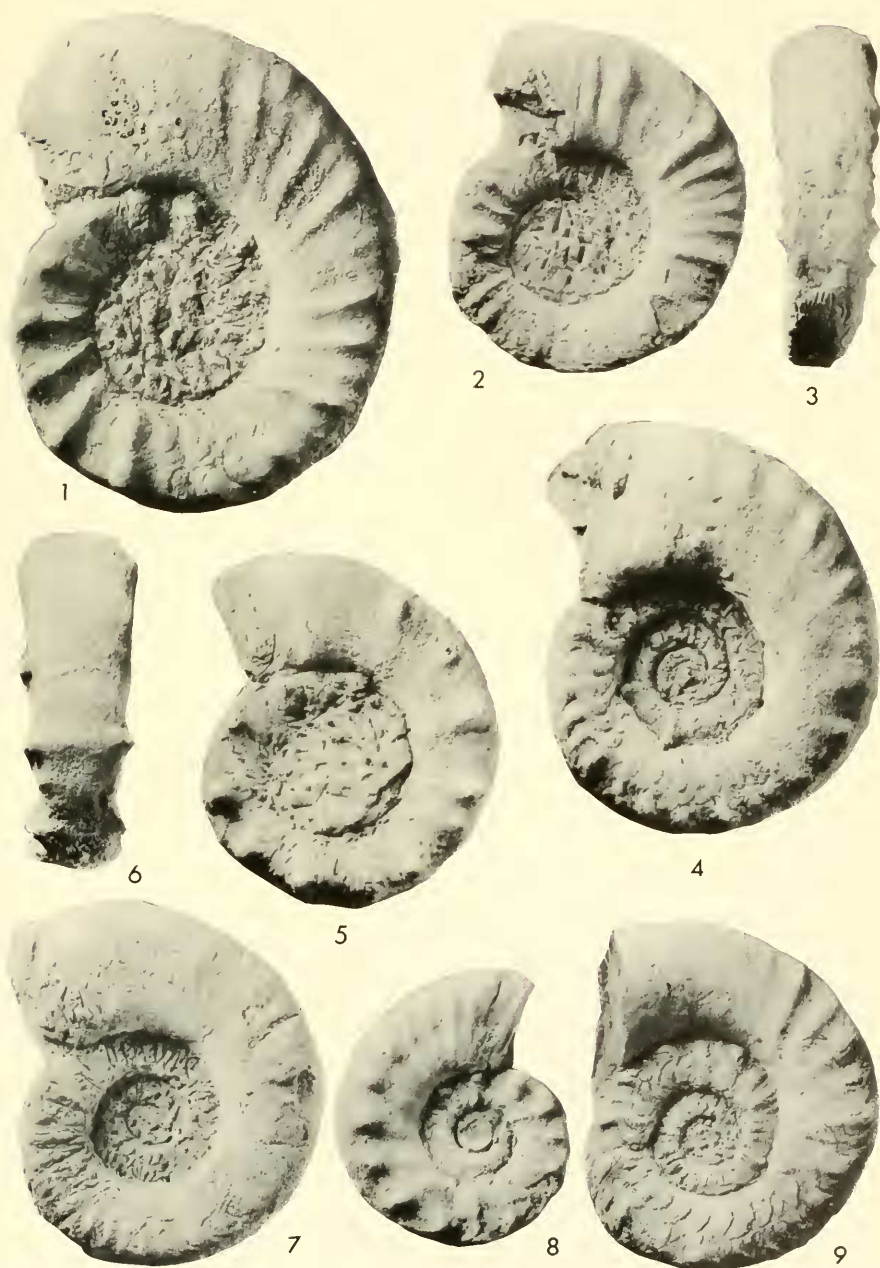


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PLATE 64. TIROLITES CASSIANUS

Figures

1-4 *Tirolites cassianus* (Quenstedt)

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Figs. 1, 2, lectotype, *Tirolites spinosior* Kittl (1903: pl. 11, fig. 5), $\times$ 1. Fig. 3, syntype, *Tirolites toulai* Kittl (1903: pl. 11, fig. 11), $\times$ 1. Fig. 4, plesiotype, *Tirolites darwini*, Kittl (1903: pl. 10, fig. 11), $\times$ 1.

All specimens are from the Werfen Formation at Muć, Dalmatia, and are deposited in the Natural History Museum, Vienna.

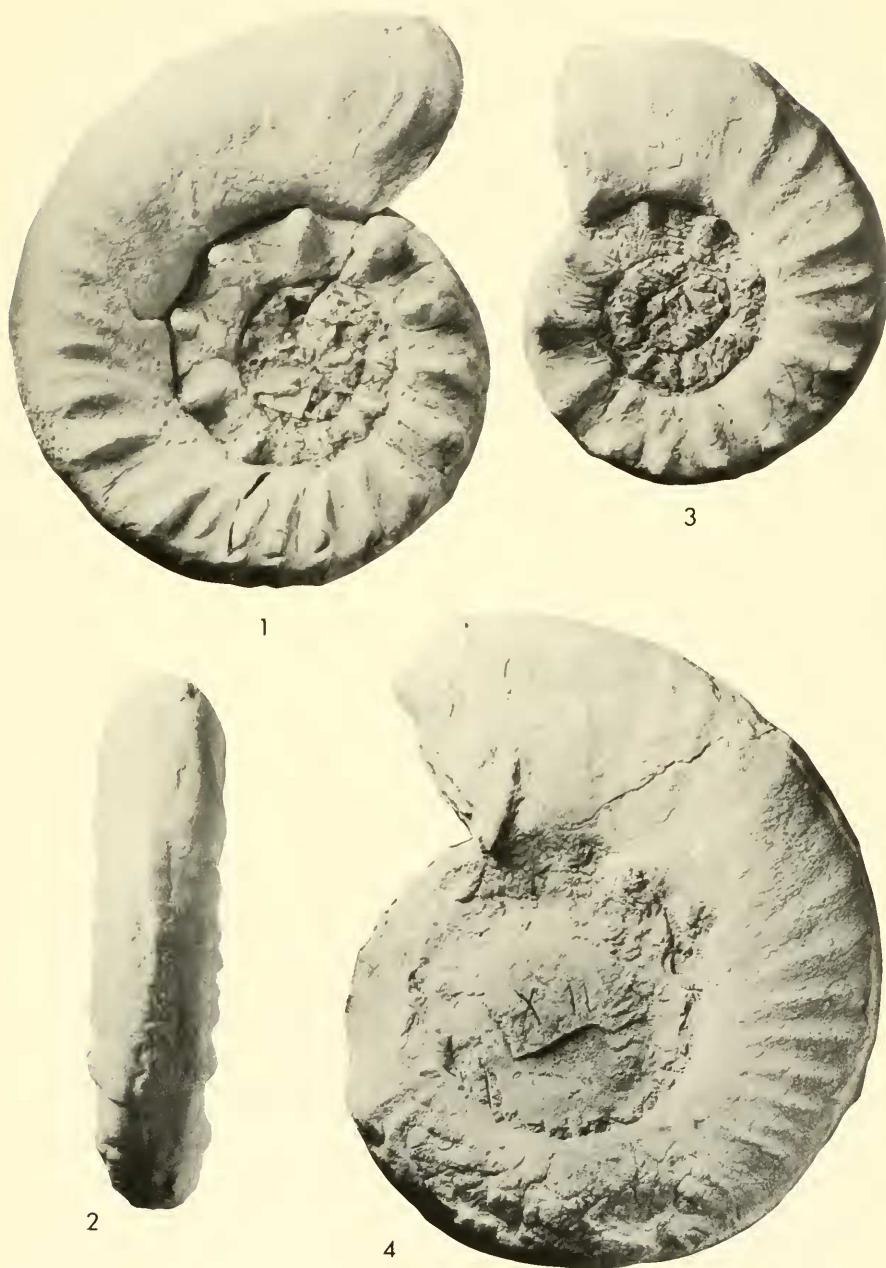


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PLATE 65. TIROLITES CASSIANUS

Figures

1-9 *Tirolites cassianus* (Quenstedt)

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Fig. 1, figured specimen, *Tirolites angustilobatus* var. *alpha* Kittl (1903: pl. 8, fig. 19), $\times$ 1. Fig. 2, lectotype, *Tirolites angustilobatus* Kittl (1903: pl. 9, fig. 3), $\times$ 1. Fig. 3, plesiotype, Kittl (1903: pl. 9, fig. 5), $\times$ 1. Fig. 4, figured specimen, *Tirolites angustilobatus* var. *alpha* Kittl (1903: pl. 9, fig. 1), $\times$ 1. Fig. 5, plesiotype, Kittl (1903: pl. 9, fig. 4), $\times$ 1. Fig. 6, plesiotype, Kittl (1903: pl. 9, fig. 6), $\times$ 1. Figs. 7, 8, plesiotype, *Tirolites spinosus*, Kittl (1903: pl. 9, fig. 7), $\times$ 1. Fig. 9, plesiotype *Tirolites haueri*, Kittl (1903: pl. 9, fig. 10), $\times$ 1.

All specimens are from the Werfen Formation at Muć, Dalmatia, and are deposited in the Natural History Museum, Vienna.

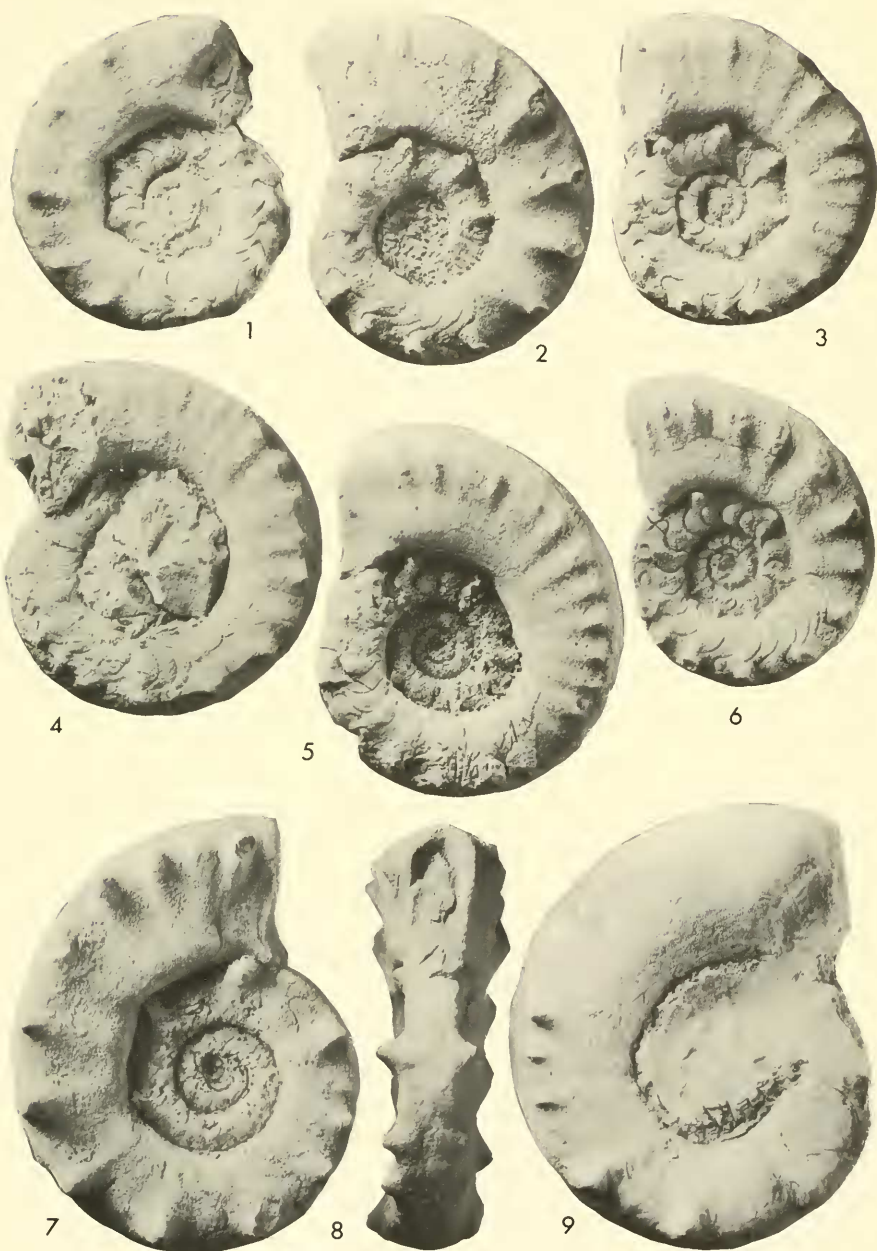


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PLATE 66. TIROLITES IDRIANUS

Figures

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1-13 *Tirolites idrianus* (Hauer)

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Fig. 1, plesiotype, *Tirolites seminudus* Mojsisovics var. *nudior* Kittl (1903: pl. 6, fig. 3), $\times$ 1. Fig. 2, plesiotype, *T. seminudus* var. *plicatus* Kittl (1903: pl. 6, fig. 7), $\times$ 1. Fig. 3, plesiotype, *T. seminudus* var. *plicatus* Kittl (1903: pl. 6, fig. 5), $\times$ 1. Fig. 4, plesiotype, *T. seminudus*, -Kittl (1903: pl. 6, fig. 6), $\times$ 1. Fig. 5, plesiotype, *T. seminudus*, -Kittl (1903: pl. 6, fig. 8), $\times$ 1. Fig. 6, paralectotype, *T. distans* Kittl (1903: pl. 6, fig. 12), $\times$ 1. Fig. 7, plesiotype, *T. seminudus*, -Kittl (1903: pl. 6, fig. 4), $\times$ 1. Fig. 8, plesiotype, *T. seminudus*, -Kittl (1903: pl. 6, fig. 18), $\times$ 1. Fig. 9, lectotype, *T. distans* Kittl (1903: pl. 6, fig. 15), $\times$ 1. Figs. 10, 11, plesiotype, *T. seminudus*, -Kittl (1903: pl. 6, fig. 10), $\times$ 1. Fig. 12, plesiotype, *T. seminudus*, -Kittl (1903: pl. 6, fig. 9), $\times$ 1. Fig. 13, plesiotype, *T. seminudus*, -Kittl (1903: pl. 6, fig. 17), $\times$ 1.

All specimens are from the Werfen Formation at Muć, Dalmatia, and are deposited in the Natural History Museum, Vienna.

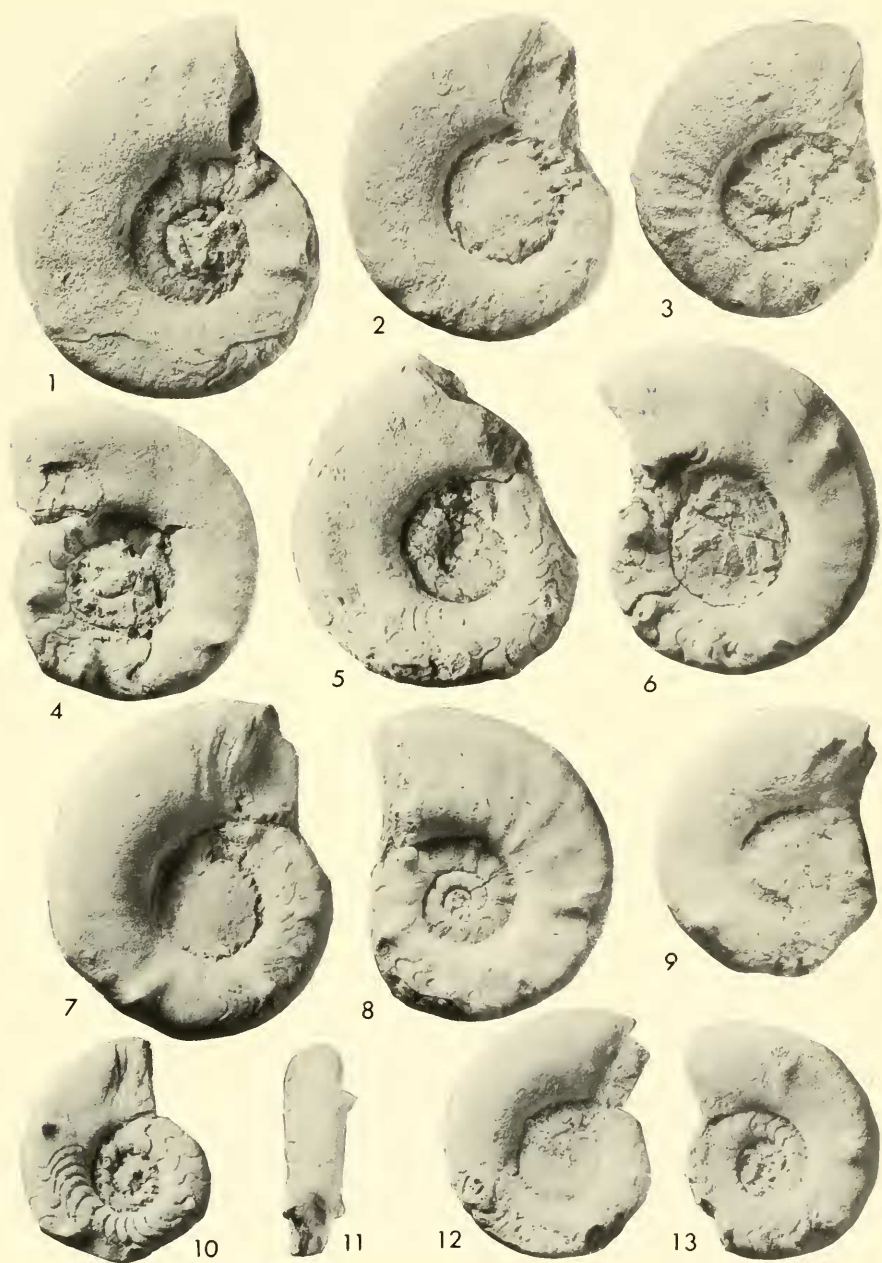


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PLATE 67. TIROLITES IDRIANUS

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1-9 *Tirolites idrianus* (Hauer)

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All specimens are from the Werfen Formation at Muć, Dalmatia, and are deposited in the Natural History Museum, Vienna.

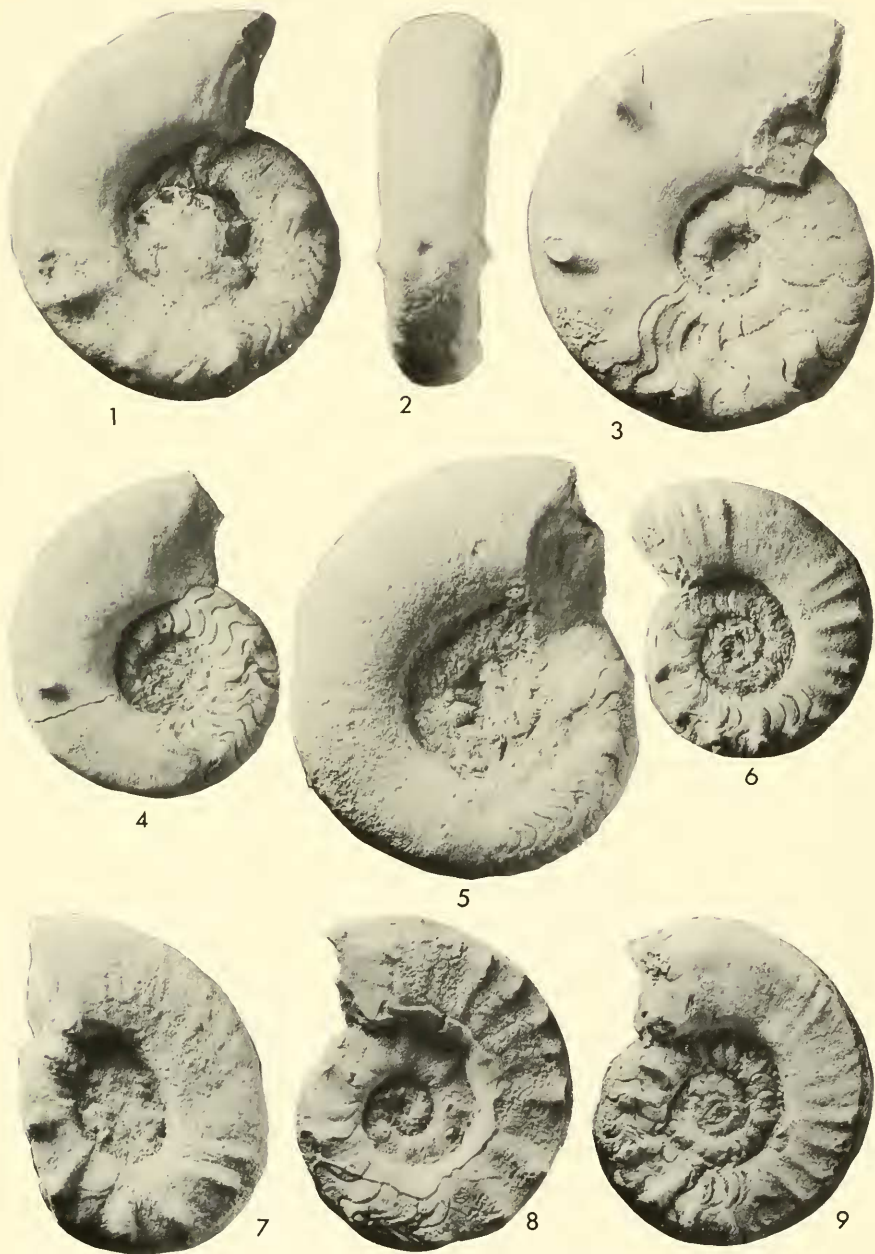


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All specimens are from the Werfen Formation at Muć, Dalmatia, and are deposited in the Natural History Museum, Vienna.



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All specimens are from the Werfen Formation at Muć, Dalmatia, and are deposited in the Natural History Museum, Vienna.

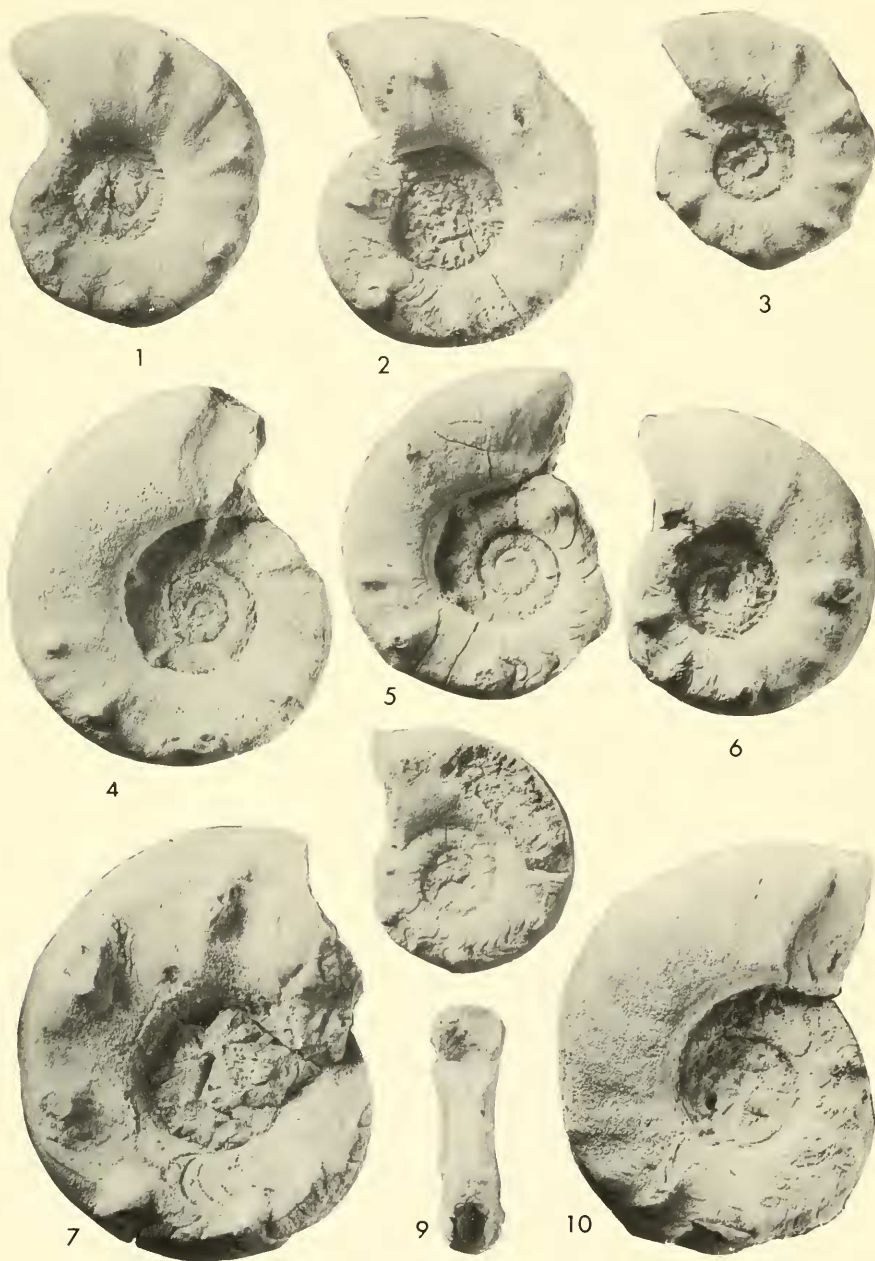


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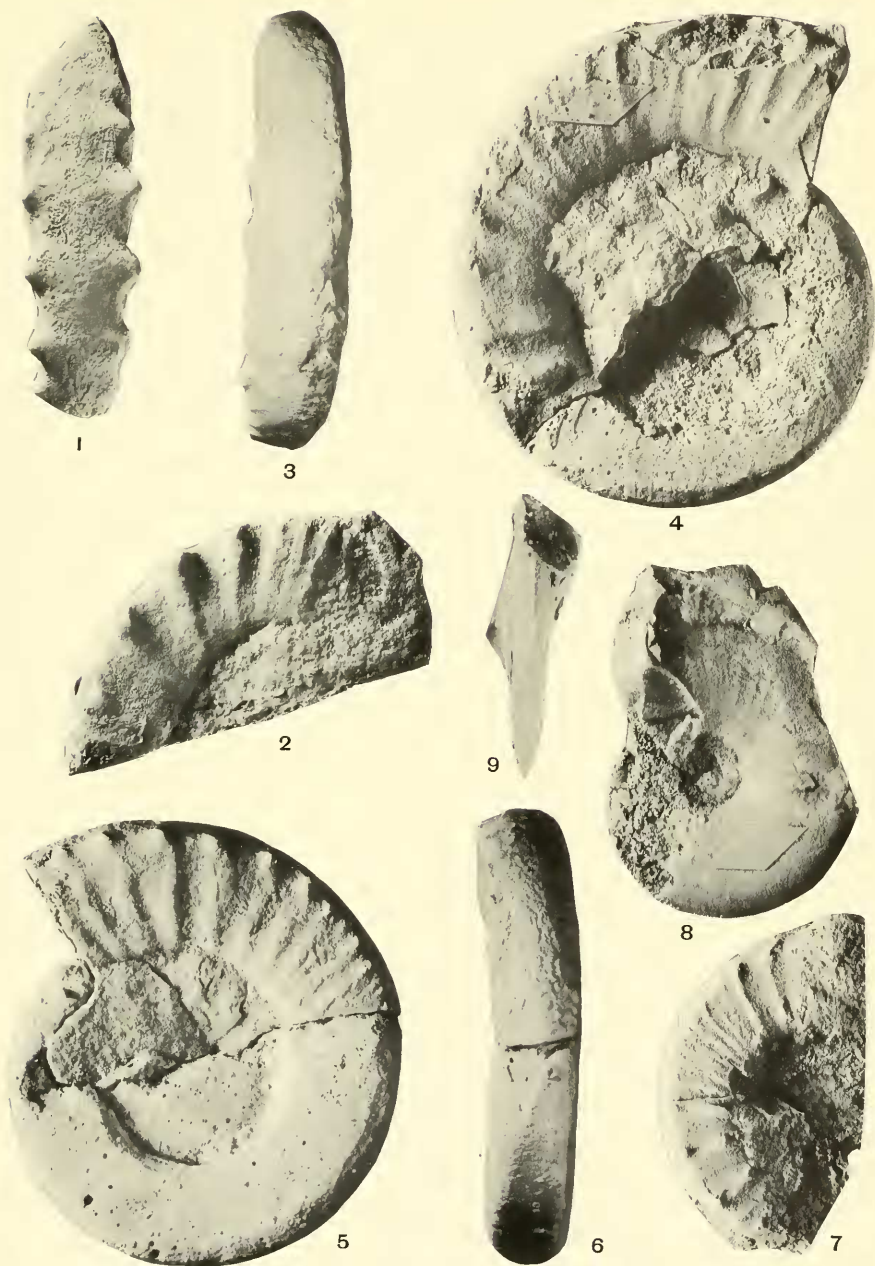


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